Photon

Issue 2
April/May 2004
http://www.nightskyobserver.com/Photon

Contents

Issue 2 April/May 2004

Editorial

Welcome to the second issue of **Photon**, the new bi-monthly astronomy magazine which aims to fill the gap left by the regular printed magazines.

We've had a very positive response to the first issue with comments such as those below being received:

Gary, great mag. Congrats on a good start.
- Walt Sanders

It looks very attractive and I'm sure you'll be swamped with pictures and articles.
- Douglas Arnold

I've downloaded the first issue to take away for the week-end to read it looks like it's wonderfully presented.
- Noeleen Lowndes

Nice going! This may inspire me to write an article on my "Wireless Telescope Control" (RTMC Merit Award 2003) **[Ed: Please do!]***. Good luck with the new magazine!*
- William Phelps

Nice looking e-magazine. I forwarded it to the Evergreen Valley College Astronomy Professor. I purchased your software last year. Works great.
- Dan Watt

Thanks for this - it sounds a great idea.
- Colin Ebdon

I feel it is a great magazine and should be a big hit. The best of luck to you with it.
- Jeff Hopkins

I just read your Photon magazine. An excellent production, good work. Well done.
- MythicalIreland

I'm sure there are several folks out there interested in this newsletter.
- Tom Teters

This new publication sounds exciting. I will download the first free issue and then get back with you and let you know what I think. I hope to submit things for publication from time to time and am also interested in talking about the Association of Lunar and Planetary Observers (ALPO) along with the Astronomical League.
- Richard Schmude, Jr.

I have looked at the samples and they are filled with good information and nicely laid out.
- Jackie Mau

Our thanks go to those who submitted articles for this issue.

Photon is written by amateurs like yourself, so if you have a topic or subject that you'd like to tell others about, please do. As I said in my first editorial, **Photon** is designed to be an international magazine. This issue sees articles from Ireland, the United Kingdom, the United States and Canada. We'd like to see material coming in from around the globe. Two areas of interest that we haven't covered so far are astrophotography (film and CCD) and the use of webcams in amateur astronomy. But keep the equipment reviews and how-to articles coming in as well.

Software is now a part of the amateur astronomer's arsenal of tools. Whether you simply use planetarium type programs for planning observing sessions or some of the freebie software for image processing or creating stacked CCD images, let us know what you think of them, their strengths and weaknesses and maybe how you think they can be improved. No one piece of software seems to provide everything in one package.

A Letters page would be good as well and, depending on the response, we could look at setting up a message board on the **Photon** webpage so folks don't have to wait till the next issue for an answer to a query!

Everybody has a funny story to tell about astronomy or some astronomical event they've been at, so send them in, no matter how small.

We're always on the lookout for astrophotos to use in the ezine, so please send us your images (and include as much info as possible on what equipment was used to take the photo, exposure times, etc.) Webcam and CCD astrophotography is now a huge interest area so if you use such equipment, let us know your experiences with it and the results you've achieved (good or bad).

Photon was originally conceived as a fee-based subscription magazine. That has now changed. All issues will now be free. Our hope is that sponsor ads and donations will help cover the production costs. If you would like to advertise (or know anyone who does), rates can be found at: **Photon Ad Rates**

If this magazine has been passed on to you, you might consider signing up for a subscription (free) so you'll be notified when the next issue is available and where it can be downloaded from. I hope you enjoy Issue 2.

Gary Nugent
photonmag@excite.com

Review: Cape Newise 200 f/6 Modified Newtonian Catadioptric Telescope

by Stephen F Tonkin

Statistics

Aperture:	200mm
Focal Length:	1200mm
Focal Ratio:	f/6
Secondary obstruction:	50mm (25%)
Length:	602mm
Weight:	9.5kg
Type:	Catadioptric; two refractive and one reflective components.
Coatings:	All non-reflective glass-air surfaces are broadband multi-coated
RRP:	GBP£1599

Description

In late 2003 the interest of the British astronomical community was piqued by the appearance of a new telescope, the **Cape Newise**. This telescope turned out to be an innovative design developed by the veteran British telescope maker/designer, Peter Wise. Wise's earlier designs have been innovative but not commercially successful.

The ***Newise*** is a catadioptric Newtonian configuration with four optical elements in the optical tube assembly as follows:

f/3 Spherical Primary Mirror
Elliptical Flat diagonal mirror (secondary)
Diverging (negative) lens group between the primary and the diagonal
Converging (positive) lens group in the focuser assembly

There is also an optical window that holds the secondary mirror/ negative lens cell. This window is flat and, like the diagonal, has no optical power.

Development

Wise's innovation is in the refractive elements. There have been earlier attempts to design catadioptric Newtonian-type telescopes with small lens elements that correct the aberrations of a spherical or paraboloidal primary but, none has been successful with respect to amateur telescopes. The most memorable of these are the Ross, Maksutov and Jones-Bird designs. Ross' corrector is a triplet lens, with no optical power, placed near the focal plane. It successfully corrects coma but is not sufficiently well-corrected for visual use. Maksutov placed a thick meniscus lens before the focal plane of fast (f/4) paraboloids but, whilst it vastly improved coma, off-axis field sharpness was poor. The Jones-Bird design successfully corrected the spherical aberration and some of the coma of slow (e.g. f/10) and medium (e.g. F/6) spherical mirrors without introducing significant on-axis chromatic aberration, but the cost was astigmatism and unacceptable field curvature. The problem faced by all of these was the need to correct three aberrations (spherical, coma, and chromatic) with a single lens. Wise has solved the problem in an obvious manner: he has used two lenses. The negative lens increases the effective focal ratio, thus permitting a smaller (25%) secondary. The positive lens corrects the aberrations of the other optical elements. The *Cape Newise* has a guaranteed wavefront of 1/8 wave and a theoretical Strehl ratio of 88%. It promised a diffraction-limited field of at least a degree in diameter. I examined the optical design and could see no flaw in Wise's predictions; the test would be to see if the theoretical promise could be met in practice..

Testing

Pete Wise lent me a prototype for testing. In the prototype, the tube is merely a vehi-

cle for the optics, and does not have the finish of the production model.. My first impression was one of a rugged, but heavy, design. At 9.5kg it is heavier than equivalent Newtonian, but significantly lighter than equivalent Maksutov-Newtonians (e.g. the ***Intes-Micro®*** MN86, a 203mm f/6 Mak-Newt, weighs nearly twice as much and is nearly twice as long as the ***Cape Newise***'s two-foot optical tube). Peter Wise advises mounting it on an HEQ-5, EQ-6, or ***Losmandy***®. My sturdiest mount was a ***Vixen Great Polaris***; it was clearly working at or beyond its limit with this telescope but, with extremely careful balancing, I could use it successfully, a testament to Vixen's excellent engineering. I used the telescope over several nights during October and November 2003 under the less than good seeing that typifies the North Downs of southern England.

It is my practice to leave a telescope outside for a couple of hours before observing, in order to make absolutely sure that it had reached thermal equilibrium. I followed this practice with the ***Cape Newise*** and consequently I have not established the cool-down time, beyond knowing that it is less than 2 hours.

The Moon through the Newise. Image by Peter Wise

Inspection of the telescope suggested that the optical window had been tampered with and an initial peep-hole test showed that the secondary assembly had been slightly rotated was out of collimation. This was simple enough to remedy. In the production model the secondary assembly is bonded to the optical window, which is itself bonded to its cell. The cell is bolted to the tube, so this rotational miscollimation will be impossible. Collimating the secondary revealed that one of the three collimation screws is fixed. This is to ensure that the separation of the secondary from the negative lens is constant. Once I had properly collimated it, it held collimation perfectly throughout the time that I had it. This "permanent" collimation is a very attractive feature of this telescope.

An initial star test on Vega confirmed excellent collimation, and the out-of-focus diffraction rings indicated the absence of spherical aberration. I was immediately taken by the distinct "snap to focus" that characterises an excellent optical system. There is no chromatic aberration in the focused image, although it does become apparent in the defocused image. The focuser is a superb, silky-smooth Crayford-type and is a sheer delight to use. Because of the overloaded mount, vibrations could take up to a few seconds to die down, but focusing could be achieved with such a light touch that, even at high magnification, the induced vibration was acceptable and only slightly reduced the ease of finding perfect focus. The focused image of this bright star was tiny and showed no flare.

Saturn, taken with a Philips Toucam Pro webcam through the Newise. Image by Martin Taylor

Mars was an obvious target in the October sky. With a 4.8mm ***TeleVue***® Radian (x250), the quality of the image during the fleeting moments of good seeing was superb, revealing a significant amount of fine detail. This image is at least as good as anything I have seen in an amateur telescope, and significantly better than that in any other catadioptric I have used.

All components of Epsilon Lyrae (the "double double") split very cleanly at x200, with inky blackness between the pin-point components when they stopped scintillating for long enough to be critically observed. An immediately obvious quality of the image in this telescope is that it is extremely contrasty.

Further observations over several sessions confirmed the excellent optical quality of this instrument. However, this can be marred by the unprotected optical window. At the first opportunity this, in a similar manner to Schmidt or Maksutov correctors, attracts dew with a vengeance. As a matter of course I keep a portable hair-dryer with my observing kit in case of such an eventuality, and the dew was easily dispersed. However, anyone contemplating buying this telescope must take this into consideration and allow for the purchase of either a dew-shield (this really ought to be standard on a telescope of this type, as it ought on Schmidt and Maksutov type telescopes) or one of the proprietary electric dew-heaters.

I am always loathe to end an observing session when I am using a high-quality instrument and this one was remarkably difficult to put away. There were times that I was relieved when clouds rolled in and I could eventually strike the observing kit and go to bed!

Summary

Pros:
Wide flat field
Pinpoint star images
Excellent contrast
Holds collimation extremely well
Compact design
Exquisite focuser
Closed tube
Significantly lighter than other high quality catadioptric Newtonians

Cons:
Heavy (compared to equivalent Newtonians)
Optical window attracts dew
Limited opportunity for user-servicing owing to precise requirements of optical design

In short, this is an extremely good telescope that offers exceptionally good value for money when compared to catadioptric Newtonians of equivalent excellent optical quality.

Causmology?

Ronald Knox once found himself embroiled in a theological argument with the scientist John Scott Haldane. "In a universe containing millions of planets," Haldane asked, "is it not inevitable that life should appear on at least one of them?" "Sir," Knox replied, "if Scotland Yard found a body in your cabin trunk, would you tell them: 'There are millions of trunks in the world - surely one of them must contain a body?' I think they would still want to know who put it there!"

Great Plague

In 1664, Czar Dmitri was allegedly told that a comet seen over Russia portended a plague in autumn, albeit one less dangerous to Russia than to other countries. Dmitri promptly set up a sanitary cordon at his borders and banned foreign ships in general (and English ships in particular) from entering Russian ports. While this part of the story may be apocryphal, Russia did in fact escape the Great Plague which ravaged the rest of Europe in 1666.

Halley's Comet

Mark Twain's birth in November 1835 was heralded by the return of Halley's comet. Twain, who often remarked upon this curiosity, came to think of himself and the comet as "unaccountable freaks," cosmically linked: having come in together, he declared, they would go out together. In fact, Twain was proven right. On the night of his death in April 1910, Halley's comet once again blazed through the sky...

Book Review

By Tim Carr

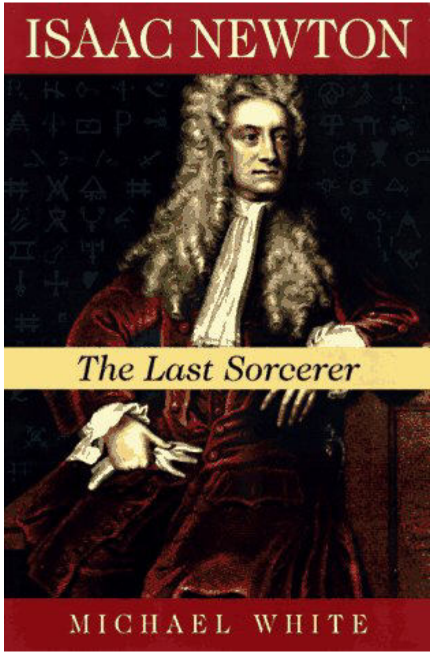
Isaac Newton - The Last Sorcerer
By Michael White

Like most people my view of Isaac Newton was the traditional one. Lonely recluse who single handedly changed our view of the universe in the most profound way - liked by few, admired by many.

Michael White's long book doesn't contradict any of this, but the picture presented here is one of a man as much preoccupied by his unorthodox religious views and an obsession with alchemy as much as the pure scientist that history has portrayed him.

Isaac Newton senior (who could just about write his name) died before his famous son was born in 1642 - the same year Galileo was born. While he was still of a young age, his mother decided to remarry, even though she was quite comfortably off. Left in the care of his grandparents, this virtual abandonment had the almost inevitable effect of making Newton turn in on himself - a characteristic he would rarely abandon in afterlife. While his mother had little use for education, his school headmaster, Henry Stokes, and relatives of his mother encouraged him to go to Cambridge. He entered in 1661 and had to start at the lowest social rung of university life.

Having to be deferential to upper class dullards did little to improve his already resentful attitude but he threw himself into his studies and impressed influential people who he would need in order to climb the college ladder. White makes clear that Newton cared deeply about such worldly things as what people thought of him. A man very easily slighted, he could harbour a grudge which, rather than fading with time, would only fester and grow.In 1664 he bought a glass prism at a fair and used it to famously show how light is made up of different colours. The following year a recurrence of plague closed Cambridge for a couple of years and it was while he was at home in Wollsthorpe that Newton made his first foray into the laws of motion, discovering the inverse square law.



By 1667 friends had convinced authorities that his work was of a calibre as to make him worthy of a fellowship, which he duly received. It is at this point that I found myself wading through a couple of chapters dealing with Newton's obsession with the ancient `science' of alchemy. I suppose a detailed history of this most popular (and pointless) of pursuits is needed to explain much of the man's odd personality. Also, White shows how these years of (to our eyes) wasted effort were actually crucial to Newton's eventual understanding of what came to be known as gravity , which is, I suppose, no small thing. Apparently his work on a substance called the Star of Regulus was a factor in realising that there was an actual physical force holding the planets in orbit around the sun.

As well as alchemy, Newton was obsessed with religion. Although a devout Christian, he embraced Arianism - a belief that God and Jesus were separate entities. This was unacceptable in 17" century England and it was necessary to obtain special permission from the king to continue as Lucasian professor without taking holy orders. Newton spent years studying the bible and became convinced that in its pages were to be found the secrets of God's creation. As with alchemy, a great deal of time is devoted to this aspect of the man's personality and only by reading the book do you realise that not only were these things important to his science (and therefore important to us) but they defined him just as much as the science he left us.

From this White moves on to a chapter called "Feuds". We have already seen examples of Newton's truculence before but now we see just how truly mean, vindictive and petty he could easily be. The slightest criticism would cause Newton to turn back in on himself. It was this that prevented him from publishing his great discoveries in mathematics, astronomy and optics. Only the friendship and cajoling of Edmund Halley brought the Principia to the world at all. But, despite his obtuseness and just downright rudeness, the Principia showed Isaac Newton to be one of the great minds of all time.

As White says: `With the Principia Newton not only unified the disparate theories of Galileo and Kepler into a single, coherent, mathematically and experimentally supported whole; he also opened the door to the industrial revolution."

One of Newton's many enemies was the great Robert Hooke whose own ideas about motion were remarkably similar to those of Newton. He even fought with Huygens when the great Dutch astronomer made the most gentle criticism of something he had done. One subject which White addresses in that of Newton's sexuality. It has long been said that he essentially had none. However, Nicholas Fatio De Duillier became , shall we say, a special friend of his and may well have been his lover. However there is no proof either way and I was left feeling that it was of less importance than one might think.

Eventually Newton had a mental breakdown over his breakup with De Duillier and when he overcame it he entered politics with some success. For the first time he had moved from the world of academe to the more `worldly' scene of London where he secured the job of reforming the royal mint. This very important position allowed him to play a crucial role in the much needed job of reforming England's finances. An insight into just how cold a fish he could be was the alacrity with which he hunted down, and had executed, counterfeiters. Late on in his life, Newton became involved in yet another dispute, this time with Leibnitz over who invented the calculus. As usual, Newton behaved badly.

Isaac Newton was a man who actually thought it was his destiny to unlock the mind of God, whether it was through science, the bible or alchemy. He possessed a great intellect and a petty mind. He could understand the most difficult scientific problem but could never fathom other people. This book is perhaps a little long-winded at times but it is a real eye-opener for people like me who previously thought Of Newton as the first modern scientist, free of medieval mysticism. He wasn't.

Comet Ferret

Charles Messier (whom Louis XV dubbed the "comet ferret") was once obliged to abandon his search for a certain comet in order to tend to his dying wife. Messier was soon dismayed to learn that the comet had been discovered by a rival astronomer, Montaigue of Limoges.

Some time later, a friend, hearing of his wife's death, expressed his sympathy for Messier's "loss." The astronomer nodded pensively. "To think that when I had discovered twelve," he said, tears pooling in his eyes, "this Montaigue should have got my thirteenth!"

Hasselblad I?

In July 1966, Michael Collins was selected to pilot NASA's three-day Gemini 10 mission. While the mission (to rendezvous and dock with an orbiting Agena rocket) was a success, Collins did make a minor blunder: during his historic space walk, he dropped a Swedish-made Hasselblad camera.

Back on earth, the astronaut was amused to learn that the Swedes had begun to refer to the camera as their country's first satellite.

Eclipsed Down Under: Totality in the Outback

By John O'Neill

The second diamond ring. This image is a single frame grabbed from a video sequence. Photo: John O'Neill

On December 4th, 2002, another southern hemisphere eclipse took place less than eighteen months after the previous totality. Amazingly, Angola, Zambia, Mozambique and Zimbabwe would again experience totality. However, this time the length of totality would be less than half that of 2001. Maximum time of 2 minutes 4 seconds would happen over the cloudy Indian Ocean. Unlike the June 2001 Eclipse, December would be the rainy season in Africa while Australia would be in the early part of summer.

For me it was not a hard choice. I had already been to Zimbabwe in 2001 and never travelled to Australia (coupled with the good weather prospects), so it had to be a "Down Under" experience. It would also be a chance to visit such astronomical sites as Siding Spring Observatory and the great "Dish" at Parkes Observatory, not to mention Sydney and Ayer's Rock (Uluru).

However, the flip side would be a very short totality. Ceduna (in Southern Australia) would get 32 seconds and inland areas even less. The eclipse site chosen would be at Koolymilka about 50km north-west of Woomera in South Australia. This is in the Woomera Prohibited Area (W.P.A.), a military area for testing rockets.

Leaving a cloudy and rainy Adelaide it was a train journey of about 450km to reach the eclipse site. As we moved north the sky progressively cleared. We disembarked at Pimba Halt near Woomera and by now the sky had totally cleared. After a tour of the Woomera Prohibited Area (W.P.A.) seeing such sights as a Gamma-Ray Telescope, the old Europa Launch Pad and dry Lake Hart we reached the eclipse site at Koolymilka by five in the evening.

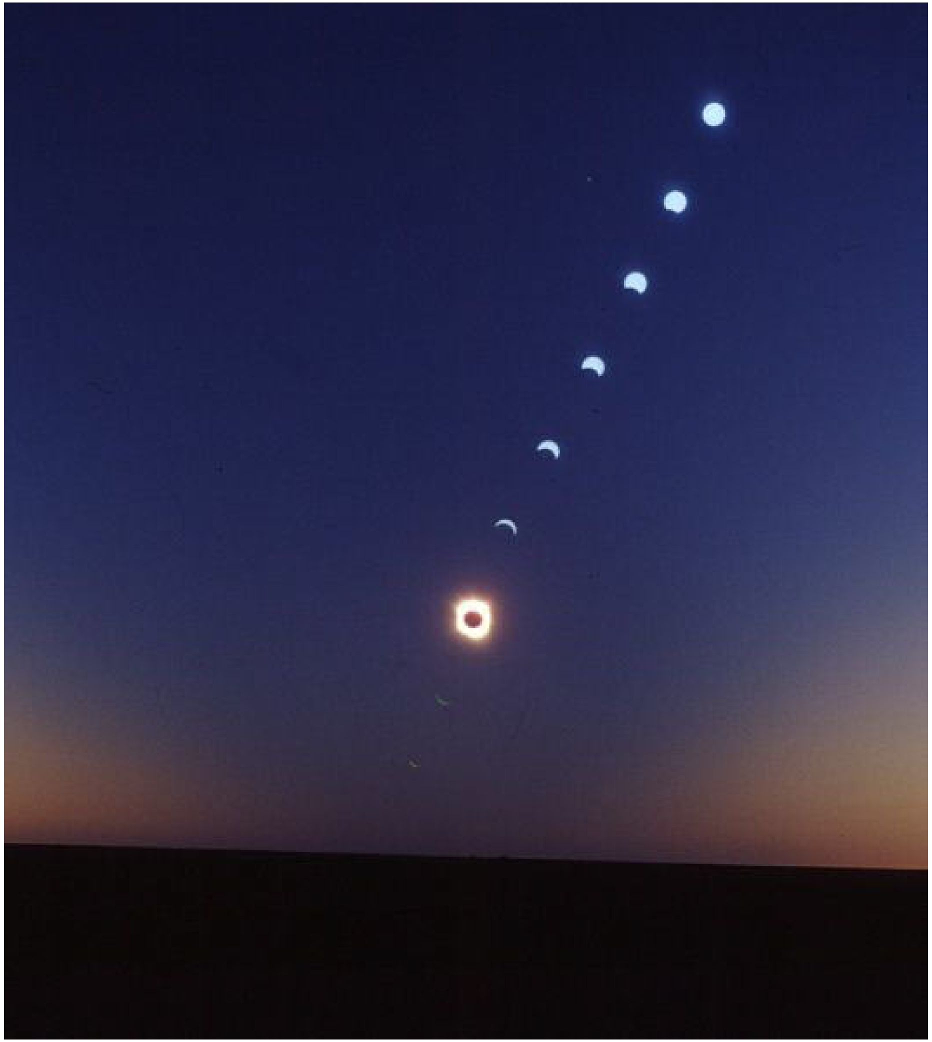
Although Koolymilka was marked on the map, it only

Koolymilka - the Eclipse Site. Photo: John O'Neill

comprised a few derelict buildings and Koolymilka Lake was dry as a bone. All around, a bleak windswept barren landscape was visible. Now I knew why a rocket range was sited here. One advantage of being in the W.P.A. was that there was plenty of room for everybody to set up. Most of the people seemed to be with our group from [Explorers Tours]. We were lined up along a chain fence set up for the occasion. The altitude of the Sun was conveniently very low. During totality it would be just 6 degrees above the horizon. The temperature was a pleasant 28 degrees C and the wind was strong - it at least kept the insects at bay.

By 18:43, a tiny tick was noticed out of the Sun – the eclipse had begun. The partial phase progressed in an orderly fashion with regular light drops and shadows getting deeper. It was still very windy.

As totality was to be only 29 seconds, I planned to concentrate on naked-eye viewing and do one multiple exposure frame showing the progress of the Eclipse. I would take a shot every 10 minutes and just do one during totality. So I would have nearly all of the precious moments of totality for soaking in the experience visually.



A multiple exposure with a 50mm lens (SLR camera) of the eclipse. Images were taken at 10-minute intervals.

In the last few minutes before totality all the preceding effects accelerated. The sky brightness fell and the insects chirped. For the final two minutes effects occurred so quickly I had no longer time to jot down notes.

The thinning crescent gave way to a stunning totality at 19:41 local time. Many Prominences flamed at the one o'clock position and on the opposite side of the sun, they were easily visible to the naked eye. The beautiful Corona was quite unlike the previous two or three totalities - it was not spiky but more graceful with small streamers.

The horizon was a deep yellow while Mercury was visible to the top right of the Sun.

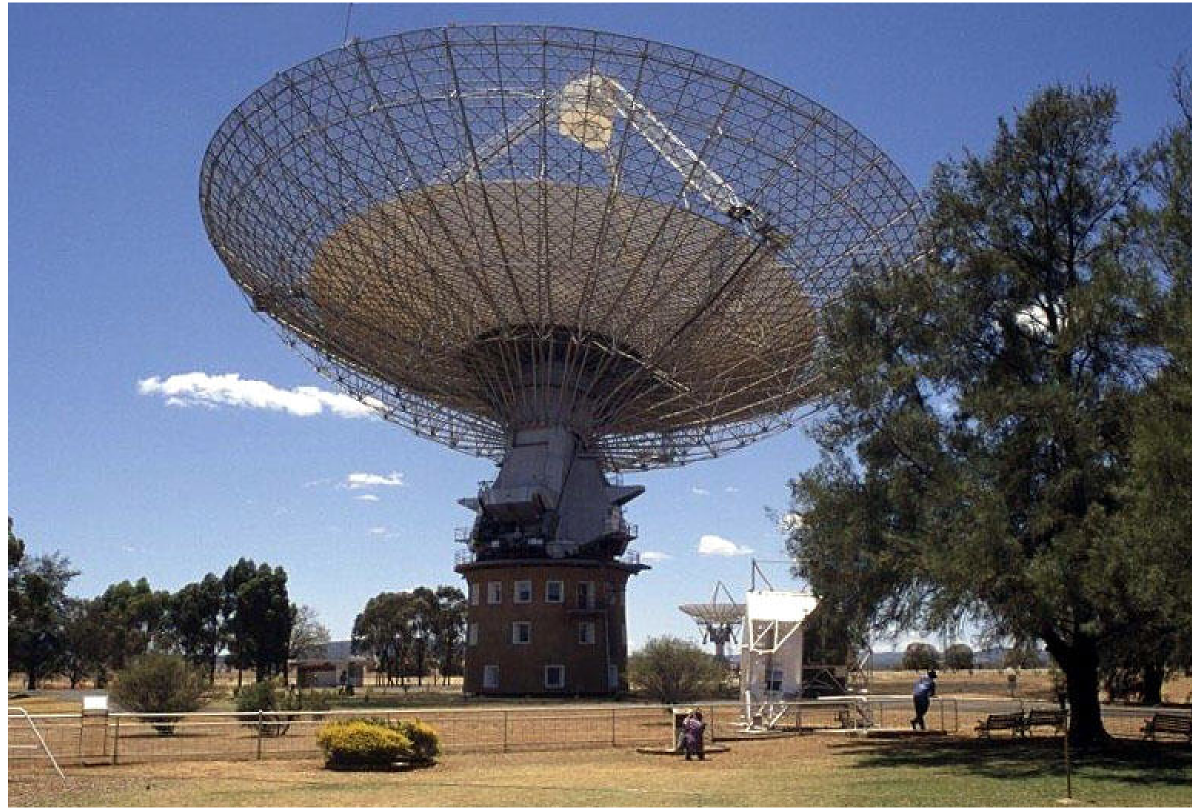
All too soon the Diamond Ring appeared, a solitaire that gradually increased in brilliance.

Although short, it was oh so sweet. To top it off, 25 minutes later the Sun set while the Eclipse was still in its partial phase. It appeared like two sails of a boat dropping below the horizon. As the last tip disappeared a splendid green flash occurred.

The only problem was that the next reasonably accessible totality would not be until 29th March 2006!

Solar Eclipse Resources

Solar Eclipse Page (Fred Espenak)
Total Solar Eclipse Website (CSIRO)
MrEclipse.com
Solar Eclipse 2002
2004 Apr 19: Partial Solar Eclipse
2004 Oct 14: Partial Solar Eclipse



The Radio Telescope at Parkes Observatory. Photo: John O'Neill

Parkes Observatory Home Page
Parkes Observatory's Support of the Apollo 11 Mission
Total Solar Eclipse of 2002 December 04
4 December 2002 solar eclipse

An Inexpensive Roll-Off Roof Observatory

By Jeff Hopkins

Introduction

Most who have a telescope have at one time or another wished for a permanent observatory in which to use their telescope. This wish is usually tempered by the cost and effort to build such an observatory. What can an amateur with a limited budget do?

Most telescopes come with tripods. They require the user to set up the tripod each time the telescope is used. Taking time for a precise polar alignment each session can get to be a real bear. For some telescopes the legs of the tripods can get in the way during observing and are easily accidentally bumped. While the newer automatic Alt/AZ fork mounted GPS telescopes help, they are expensive and on the heavy side. Leaving a telescope set up and unprotected is usually not an option. For serious observing where precise alignment is desired for finding and tracking objects, a permanent mount is the first answer.

While building an observatory is usually seen as a difficult and expensive venture, it need not be. A very nice observatory can built for a reasonable amount of money and effort. Using surplus or scrape material can save even more. To further help when funds and time are tight the project can be done in steps or phases over several weeks or months. At the completion of each phase you will have a better observing situation than before.

I have a very nice two story cement block 12 foot square observatory with a Celestron C-8 setup on a permanent mount on the second floor. A simple rectangular hole in the roof covered by a sheet metal section. The section can be slid off during observing sessions and then slid back in place and tied down. Originally I rolled the whole roof off, but it was way too heavy and I had all kinds of problems. The last time I had problems I bolted the roof down and cut the smaller opening over the telescope. This has worked well for many years. I first used fibreglass sheets as the covering material for the removable section. While the weather is normally wonderful in Phoenix, occasionally we get storms with high winds. Some gusts border on hurricane velocity. The first time that happened the fibreglass was shredded. I then used aluminum. The next big storm shredded that too. I finally settled on galvanized metal roofing sheets. While heavier, these have survived now for several years. This observatory has served me well and I have dedicated it to photoelectric photometry.

A few years ago I purchased a Celestron 4" refractor and planned to use it for solar system observing, particularly lunar observing. Hauling it in and out of the house became a chore. Being spoiled by the first observatory I decided it was time for a permanent mount for the refractor. This led to my next observatory which evolved in phases. The following is a description of these phases. Your observatory can be build using the following as a guide.

The Pier and Mount (Phase I)

The first phase was to make a permanent mount so I could just take the telescope in and out of the house and leave the mount setup. I located a spot in my backyard with enough room and a fairly good view of the sky. For the pier I used is a 2.5" steel water pipe (I do not recommend use of conduit pipe, while cheaper, as it is much weaker) filled with concrete and treaded at the top. The pipe is available at most any hardware store. The pipe comes in ten foot lengths. The store can cut it to length for you and tread it if not already treaded on one end. The pipe diameter may seem a tad too small, but the water pipe is quite sturdy, plus I was able to stiffen it even more as will be seen later. A larger diameter pipe would be nice, but more expensive and would complicate the mounting.

The pipe I used has a total length of 100" (24" in the ground and 76" above ground). The length of the pipe should be such that it provides easy viewing when the eyepiece is at its lowest point. Keep in mind you may

Fig.1: Pier Flange Close-up

Fig.2: Pier with 4" Telescope

be adding a permanent platform later. For a refractor, the eyepiece is lowest when observing close to the zenith. For lower altitude observing the eyepiece is then quite high. My thought was it would be easier to make a temporary moveable platform to allow easier viewing with high eyepiece positions than try to view when the eyepiece was too low. You will need to do some hard thinking on just how high you want the telescope to be. If you have something other than a refractor, then the height of the pipe will certainly be different. I dug a 2 1/2 foot hole, partially filled it with concrete, inserted and leveled (made sure it was vertical) the pipe and filled the rest of the hole and pipe with concrete. Final positioning and truing of the pipe can be done after the concrete has settled some and before it hardens.

The threaded end of the pipe should be at the top. When filling the pipe with concrete you can protect the threads with masking or electrical tape . A standard 2.5" pipe flange can be purchased at the same hardware store. This will screw onto the top of the pipe and provide a platform to connect the telescope mount. The exact interface will be determined by the telescope mount. To make azimuth adjustment easy, I drilled and tapped a hole in the threaded side of the flange and used a set screw to lock the flange into position on the pipe. This allows a rough azimuth alignment with the fine adjustment provided by the telescope mount. Figure 1 shows a close-up of the flange and Figure 2 shows the result of the first phase with the 4" refractor mounted.

Platform (Phase II)

Shortly after getting the first phase completed I got aperture fever and bought a Meade 6" refractor. While the 2.5" pipe worked well for the 4" refractor, it was borderline for the 6". I solved the problem by adding 8" X 8" X 8" concrete blocks around the pipe filled with concrete. This increased the mass and stiffness of the pier to an acceptable level with very little added expense and effort.

After a few observing sessions it became obvious I needed a platform to provide a level and stable surface during observing. The height of the pier was such that I needed a sizable platform for anything other than near zenith observing. At first I made a small 2 foot square moveable platform. But I was still stumbling around on uneven ground at night. My two dogs keep me challenged by continually digging in the yard, sometimes while I was observing. More than once I nearly fell over from a newly dug hole. After falling off the platform one night, I moved my observing chair too close to the edge, I decided something must be done to make the situation better.

The answer was to build a larger permanent platform. I

Fig.3: Platform and 6" Refractor

started out with a 4 foot by 8 foot platform using a painted 3/4" plywood sheet (with opening cut for the pier) mounted on 8 foot 2" X 6" planks sitting on three rows of three 8" x 8" X 16" concrete blocks. One row on front and back and one in the middle. The plywood is secured to the planks with screws. I made the opening for the pier at least one inch larger on all sides so as to isolate the pier from the platform. It is important to rack and get the ground around the platform as level as possible before starting this phase. Fine adjustment to the leveling can be done at each concrete block using the 8 foot planks before the plywood is added.

Note: Because the platform and subsequent observatory is just sitting on the concrete blocks, no building permit was required. You will need to check your local requirements, however. Figure 3 shows the results of the second phase.

Basic Enclosure (Phase III)

While the new platform worked well, I decided to expand it to 8 foot square. This can easily be scaled to other sizes, e.g.., 12 foot square. It's best to keep the size in multiples of four feet to optimise the siding and floor cost. To do the expansion I added another 4 foot by 8 foot platform section to the section already in place. I did this by using two-2 foot by 8 foot sections of 3/4" plywood, one added to the front and the other to the back of the existing platform. As before I used concrete blocks and 8 foot 2" X 6" planks. The new platform worked well, but was a bit spongy. To stiffen it, two more 3/4" 4 foot by 8 foot plywood sections were added on top of the platform and oriented perpendicular to the existing floor. The floor to the top of the pipe is now 60". The telescope mount is above that.

Because there is always a need for AC power, I dug a trench and laid conduit with wiring from the original observatory.

Fig.4: Enclosure with 3 walls

During observing sessions I found I had some severe new light pollution due to neighbours mounting high intensity lights in their backyards along with a couple of street lights just at the wrong height and position. To counter this I decided to add walls to the platform. To do this I added 2" X 4" framing on top of the platform. The framing is covered with siding. All fastening was done with metal screws. These screws used to be used exclusively for drywall and plasterboard, but were found so handy that now there is a large variety of sizes and finishes. The screws with the outdoor finish (called Deck Screws) is recommended. However, if the siding is painted, it really doesn't matter and the Deck screws are more expensive. The screws provided a better bond than nails and make adjusting where necessary, much easier. Using a variable speed drill to screw them into place is easier and quieter than hammering nails. If you pre-drill holes in the top pieces, it makes positioning the screws and wood pieces much easier. I decided on walls 7 foot high. This would still give me fairly good access to the sky yet block all the stay light and most wind. I didn't have to cut the 8 foot siding to 7 feet as I just slid it down forming a skirt around the observatory. This saved time and effort. I used 24" centering for the studs, however, 16" centering could be used, but I did not feel the added cost of the studs was necessary. Because there

is no permanent roof, I added 2 foot corner braces at the top of each corner under the top 2" X 4"s.

Figure 4 shows the progress up to three walls. Figure 5 shows the observatory with four walls and the start of the roof. I used a large tarp to cover the top opening while getting ready to add the roll-off roof. This allowed continued observing during the several weeks before the roof was finished.

Finished Observatory (Phase IV)

I decided to make the roof a simple slant roof covered with galvanized sheet metal roofing. Other configurations will work too, however, they will complicate the building, cost more, weigh more and make the roll-off harder. The exact slant can be whatever suits you. Since there is never snow in Phoenix, most any slant would work here, even flat. I decided on one foot high in front. In high snow areas, a steeper slant maybe in order. The metal will cause the snow to slide off if the slant is steep enough. The slant meant I had to use more than 8 foot long sections of metal roofing. I looked at other roof coverings, but the metal seemed best both economically and weight wise. I wanted something light enough to allow easy manual rolling of the roof. I used 8 foot length and cut some to 4 foot lengths to overlap to provide the coverage with 6" overhang at both ends.

The roof outrigger is made with 8 foot 2" X 6" planks for the upper portion supported by two 4" X 4" X 10 foot posts sunk in the ground with concrete around them. An 8 foot 2" X 4" plank across the upper back supplies the stiffness to keep the outrigger square. I used 3/8" bolts to secure the planks to the 4" X 4" posts and metal hangers on the side of the observatory to hold the 2" X 6" planks. Figure 6 shows the finished observatory. I have been using the observatory much and am very pleased with it.

Fig.5: Enclosure with walls

Designing a method to support the roof and allow easy roll-off was a challenge. I went through several designs each seeming more complex than the previous. I then decide to make the mechanism as simple and inexpensive as possible. This involved using just wood and inexpensive rollers. I cut sections out from the base of the roof and mounted the rollers. I used three rollers in front and three in the back. To keep the roof guided while rolling I added guide rollers in each corner. I used 3/8" bolts and some spare nylon rollers I had for the guide rollers. Most anything can be used, however. I build a prototype to experiment some before building the rest. The design appears to work well. Figures 7 (a - c) shows close-ups of the roller mechanism with a guider. The middle rollers do not have the guide roller. Note the slot in the corner top 2" X 4" to accommodate the guide roller. When not rolled off the roof is bolted down with two 3/8" bolts, one on each side, none on front and back, with wing nuts for easy use. See Figure 7d. I use a six foot length of 3/16" nylon rope to help pull the roof off and back on. The finished observatory was painted with 2 two coats of exterior flat white enamel. The red dragon was given to me by my sister and sits by the door for protection.

Conclusion

While it took me close to six months to design and build the observatory, I took my time. Someone determined could certainly build one like it in a week or two. I added a discarded metal door, but any type door will suffice. The door allows a means of securing the observatory when I am not at home. I added a 2 foot square window to allow me to see toward my house. This is optional, but if a window is added, make sure it is not in a position to allow undo stay light into the observatory. I have been using the observatory for several months now and am very pleased with it. It takes only a minute or two to unbolt and slide the roof off. I have found the 8 foot square design to be good and provide a surprise benefit. I tend to hold onto or rest against the studs during observing. This helps keep me oriented and steady at night. A larger observatory would not provide that.

Fig.7a: Corner Roller and Guider

Fig.6: Enclosure with Roll-Off Roof

Resources

Jeff Hopkins Webpage: [HPO Astronomy]

Fig.7b: Corner Roller and Guider with Brace

Fig.7c: Side Roller

Fig.7d: Bolt Down with Stop

Outback Observing

By Kevin Berwick

On a visit to Australia last summer I took the opportunity to look up Rudi Vavra, who contacted me on the Internet a couple of years ago in order to look for my opinion on Televue telescopes. We have been in contact for a couple of years now and there has been a standing invitation to visit each others country for that time. An enthusiastic astronomer, Rudi has so far resisted the opportunity to examine the cloud base in Ireland at high magnification, but I was delighted to accept an invitation to join himself and some other members of the Wollongong Amateur Astronomy Club to join them for an observing night.

Wollongong is an attractive coastal town 80km south of Sydney, offering sunshine and good surf on some fabulous beaches including the nearby "picture-postcard" 7 mile beach. A combination of perfect weather and the stunning southern skies transform the countryside surrounding the town into an astronomical playground as the sun sets on yet another cloudless day.

Wollongong at night

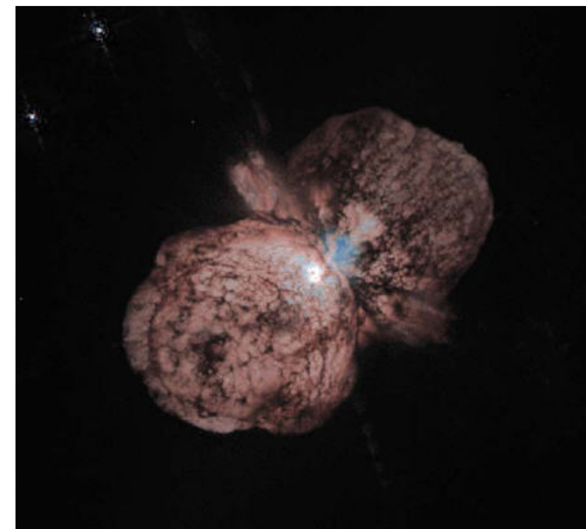
I couldn't believe it when Saturday dawned and the weather was cloudy and stormy looking. However, it started to clear in the afternoon and as we set off Rudi assured me that all would be well with the weather. To be honest, I put his assurances down to the irrepressible Aussie optimism which only a nation that lives under several hundred days of sunshine per year can have!! However, he was right, the further we drove the better it became.
On our way, we bought a hot dinner of roast chicken and vegetables as we drove to the Cataract Scout Camp north of the city, arriving just as darkness fell. We ate in style as the stars appeared. Rudi even had hot water for fresh coffee. Deluxe observing indeed!! I was glad of the hot dinner later in the evening as it did get quite cold.

The site really was fabulous, the Milky way was very impressive and both the Small and Large Magellanic Clouds were clearly visible. All around me, various telescopes were being set up including Rudi's N102, a 10-inch LX200, a 6-inch achromat on an equatorial, a Meade ETX90EC, a highly modified 10-inch Meade Dobsonian and a homemade 6-inch Dobsonian. Also present was an Orion 80mm ShortTube refractor and 20X80 and 7X50 binoculars.

This really was shaping up to be a night to remember, an opportunity to compare a number of different scopes as well as a look at the wonders of the Southern sky.

A couple of the members complained to me about encroaching light pollution from a nearby mine, but compared to the conditions that I have lived with all my life in Ireland and England, it was superb.

Rudi was very keen that I take a look through his Tele-Vue TV102 in order to compare it to my TV101. He decided to show me the area around Eta Carina as an



A huge, billowing pair of gas and dust clouds are captured in this stunning NASA Hubble Space Telescope image of the supermassive star Eta Carinae. Photo: Jon Morse (University of Colorado), and NASA

47 Tucanae, the second largest and second brightest globular cluster in the sky
Photo: Two Micron All Sky Survey (2MASS)

introduction to the southern deep sky. After Rudi pointed the scope I had a look and was hit by the most visually stunning astronomical image I have ever seen through any telescope. This incredible star field has it all, nebulosity, dark lanes, clusters and nestling in the centre, an exploding star. Delicate swathes of nebulosity envelop yellow Eta Carina, with the famous lobes visible at around 100X. One lobe from the star is distinctly brighter than the other. It is hard to compare it to any Northern Hemisphere object but I can say that it is even more impressive than the Orion nebula, high praise indeed.!! Unfortunately for Rudi, I had never seen anything as spectacular in the Northern hemisphere so it was very difficult to judge his telescope.

As the night wore on I did have a chance to properly assess the TV102. It is a superb performer, stars are sharp to the edge of the field with excellent contrast. Although I haven't had the opportunity to do a side-by-side comparison, I can't imagine there being any difference between it and my TV101.

Next up was Omega Centauri, well resolved in both the TV102 and the 6-inch achromat. This thing is enormous, much bigger than M13. It is also curiously uniform in brightness across the object. There appears to be no obvious condensation towards the centre, unlike say M92.

47 Tucanae was another fantastic globular, another of Rudi's favourites. It appeared to have a uniform disc of stars in the centre of the globular, again a feature I haven't seen before in a globular.

The Tarantula nebula in the Large Magellanic Cloud was another breathtaking sight, again without parallel in the Northern sky. The 'legs' of the 'spider' were incredibly clear.

A lot of spectacular objects visible in Ireland are quite far south and therefore low in the sky. An advantage of being in the Southern hemisphere is that these objects ride high in the sky allowing far more detail to be seen. So an exploration of Sagittarius and Scorpio was next

Composite colour image of the Tarantula Nebula in the Large Magellanic Cloud (LMC) and its surroundings. Photo: European Southern Observatory (ESO).

on my list. The Lagoon and Triffid nebula were 'photo-like' in quality from the site. Although naturally devoid of colour and a bit dimmer than an overexposed astro-photograph, all the detail was there, even through a 4-inch. The dust lanes in both nebulae jumped out at you and the shape was exactly as you'd expect from the photos I've seen on the back pages of *Sky and Telescope*. I spent a while exploring open clusters in the sky, particularly in the area around Eta Carina which has an embarrassment of riches in this, and so may other, respects. Indeed, this was the object I came back to most, I must have looked at it through every telescope and eyepiece present that night.

Everyone there was incredibly generous with their time and equipment, almost vying to offer me looks at various southern showpieces. They really were a great bunch of people. Rudi already has an 'appreciation' of the less than favourable observing conditions in Ireland and indeed Northern Europe in general. I thought that the rest of the club would take their good fortune to be living in Australia while pursuing their hobby for granted. However, they all seemed to be very aware of conditions overseas and literally 'counted their lucky stars' they were in Wollongong. Australian amateurs have an amazing number of advantages over their northern hemisphere counterparts and I think it may be worth listing them here.

1. The country has a low population density and therefore very little light pollution, particularly away from the coast where most people live
2. Many of the most spectacular objects in the sky are in the southern sky.
3. The planets in general are higher up at opposition.
4. The weather is excellent, and (most of the time) the skies are clear.

Box jellyfish that are lethal - the class Cubozoa, order Cubomedusae, family Chirodropidae, genera Chironex and Chiropsalmus, occur widely from Queensland, Australia northward to about Malaya. These forms, with a toxin with an LD 50 of 40 micrograms/kg are dangerously venomous. Even a moderate sting can cause death within a few minutes and has a reported mortality of 20% with deaths occuring secondary to respiratory paralysis, neuromuscular paralysis drowning, and cardiovascular collapse.

In fact the only disadvantage at present is that it is expensive to import a telescope. Once you get one however, I can't think of anywhere better to be an astronomer.

Dave Finlay started doing some astrophotography, including a wide angle shot of the Southern Milky Way with a 35mm camera piggyback on his LX200. He painted us all with light from his red torch which should produce a spectacular photo.

It did cloud over for around an hour and we sat around chatting. This was a chance to allow my hosts to indulge in what I learned is a favourite pastime of Aussies - that is scaring the living daylights out of soft Europeans with tales of their yicious/toxic wildlife. Paul Lovasz, the owner of the 6 inch refractor, had the best story about box jellyfish which come ashore in Queensland in large numbers at certain times of the year. He said that people who have been stung by these creatures often suffer damaged vocal chords. I was very surprised by this and asked if the toxin preferentially attacked the vocal chords. This produced the deadpan response, 'No mate, it's the screaming!!!!'.
I was in Cairns for a fortnight later on my trip but I have to say that despite the jellyfish season being long over, I didn't enjoy my swimming at all. The words Coral Reef and violent death are now inextricably linked in my mind!! Interestingly, I did tell a few Aussies that story and even they were impressed!!! It is also my favourite pub story here in Ireland, if tourism numbers to Oz are down next year, blame me!!

Another pleasure of the evening was to view all the various telescopes. Particularly impressive was Laurie Marshall's fully loaded Meade 10-inch Dob which offers the last word in observational convenience thanks to a large number of ingenious DIY enhancements. These include an electric focuser, dew heaters made from electric blanket wire and a built in heated cabinet to keep eyepieces free of dew. A low battery indicator and Digital Setting Circles complete the very impressive set-up.

I also had a close look at Brian Tyne's ETX. This scope has a very impressive GOTO computer, offering almost a page of information on some objects and nice sharp optics. The field of view is a little narrow, inevitable with a Maksutov design. Another great scope to keep handy in your car, I can now see why it's been such a huge success.

Another telescope I had a close look at was Paul Lovasz's 6-inch Chinese achromat. The price of a 6-inch refractor has plunged in the last few years thanks to the entry of the Chinese to this market. These 6-inch refractors can now be bought for around €1000 complete with an equatorial mount. This scope was a great performer on low power. Stars were pinsharp and the contrast was far superior to that offered by a reflector. Also the chromatic aberration is not obtrusive on these objects. The moon is also excellent through this telescope. Where it really falls down though is on the planets. You do get a serious amount of purple around these bright objects. Paul, the owner told me that an accessory now available called a Chromacorr cures this colour problem and offers near APO performance but it isn't cheap.

Interestingly, Paul also owns a similar 4 inch Chinese refractor from the same maker as his 6 inch so he has obviously been taken with these scopes. An enlightened refractor buff like myself!!!!!, he also had a fast Orion ShortTube 80mm refractor on a photo tripod. This was an excellent little widefield scope and incredibly convenient. You can easily lift the tube and tripod in one hand and I'm sure you could stow both in the glove compartment of a car, an ideal 'grab and go' combination. If I ever see one of these scopes second-hand I'll jump on it.

The evening ended at 4am with a simple, yet uniquely Australian, experience, watching the Moon rise behind the branches of a gum tree, a fitting end to a night I'll never forget. As I write this piece the sky is cloudy to the horizon, I've been home 2 weeks and have had one clear(ish) night. What more can I say? Point your browser now to http://www.qantas.com.au You won't regret it!!

Did You Know?

The Apollo program initially included plans for 21 missions. Missions 18-21 were cancelled due to lack of funds and a changing political climate.

As a traditional sign of peace, Buzz Aldrin (Apollo 11) planned to leave on the Moon a small gold olive branch, along with an Apollo 1 patch and two Russian cosmonaut medallions in honour of those killed in the space race. He forgot until the last moment, and simply tossed them unceremoniously onto the surface on his way back up the ladder. The astronauts also chucked out their moon-boots, backpacks, a sack of garbage and their urine bags.

One of the things that the Apollo 11 mission did was deposit a cockroach on the moon. During their outward flight, the astronauts noticed a cockroach in their spaceship, but when they returned, the craft was thoroughly inspected by NASA technicians and no trace of it was found. The only conclusion is that it crept out and was left behind.

The magnitude of a full Moon never fails to impress, but this brightness is deceptive. The satellite's surface is actually quite dark. Its albedo, the fraction of the total light that is reflected from it, is on average only 6.7%, lower than all the planets except Mercury.

Lunation

A lunation is commonly defined as the mean time between successive new moons. However, as a result of the influence of the Sun on the moon's orbital motions, the actual time interval between consecutive new moons varies considerably but averages 29 days, 12 hours, 44 minutes.

Apogee and Perigee

As is the case with all orbits, the moon's is elliptical rather than circular with the Earth sitting at one of the focus points of this ellipse. This means that during the course of its monthly orbit of our planet, the moon is sometimes closer to Earth and sometimes farther away.

The terms **Apogee** and **Perigee** are used to describe these two maximum and minimum distances from Earth. They refer to when the moon is in specific positions in its orbit - Apogee is when it's at its farthest from Earth during its orbit and Perigee is when it's at its closest.

Due to a combination of factors (primarily from the Earth and the Sun), the moon's orbit precesses about the Earth and results in the times and distances of the apogee and perigee points changing from month to month. On occasion, the moon can make comparatively close approaches to the Earth during Perigee. One such close approach occurred in December 2002 when the moon came as close as 367,903 km, appearing slightly larger in the sky than usual. It was estimated to have been about 14% brighter than normal at full moon as a result.

Libration

The moon's elliptical orbit has another consequence for the observer. Over time, the moon appears to 'nod' left and right and up and down slightly. This effect is known as Libration.

As on Earth, the position of features on the Moon are measured in latitude and longitude (called Selenographic Latitude and Longitude). The lunar equator lies at 0 degrees latitude and the prime meridian (at 0 degrees longitude), runs from the north to south poles along the (vertical) running down the centre of the moon's disk.

As explained in the last article, the moon always presents the same face to observers since it takes as long to turn once on its axis as it does to complete one orbit of the Earth.

Since the Moon's orbit is elliptical rather than circular, the moon speeds up near perigee and slows down near apogee in accordance with Kepler's laws. The Moon's axial rotation speed remains essentially constant from month to month as a consequence of the conservation of angular momentum.

The Moon's orbit is also tilted to the ecliptic plane and to the Earth's equator by about 5 degrees. All these factors combine to make the Moon appear to nod from side to side and up and down during a lunar month, and it is possible to observe about 59% of the Moon's surface over a period of time, although we can only see 50% at any one instant.

There are, in fact, three types of libration involved in the moon's motions. Libration in latitude (up/down movement) is due to the Moon's axis being slightly inclined relative to the Earth's. Each of the lunar poles will appear to be alternately tipped slightly toward and away from the terrestrial observer over a roughly four week cycle.

Why were the lunation counts started in 1922?

Lunation 1 on January 16, 1923 was the first lunar synodic month for which Prof. Ernest Brown at Yale University had detailed lunar occultation data for developing his mathematical models of lunar motion. The 'Brown Theory' of lunar motion forms the basis for modern predictions of lunar motion, eclipses and occultation events. A synodic month, or lunation, begins at the New Moon and runs until the next New Moon 29.5 days later.

Diurnal libration is due to the observer being up to four thousand miles to one side of the Earth-Moon axis on the surface of the Earth - a significant proportion of the centre-to-centre distance. The difference in perspective between the rising and setting of the Moon appears as a slight turning of the Moon first to the west and then to the east.

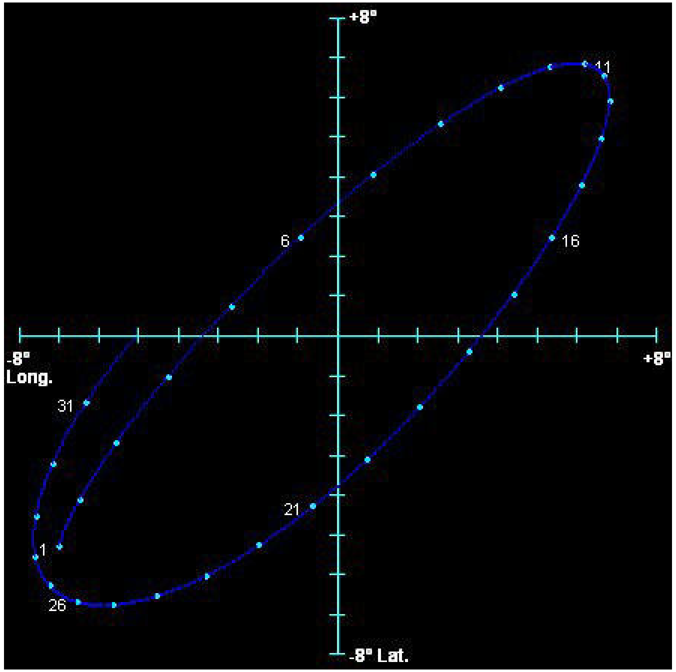


Fig.1: Geocentric Libration Diagram for May 2004.

Libration of longitude is an effect of the Moon's varying rate of travel along its slightly elliptical orbit. Its rotation on its own axis is more regular, the difference appearing again as a slight east-west oscillation.

At very favourable librations, the moon can rotate by as much as 8 degrees in latitude or longitude, bringing features that are normally on the limb into better view (as was the case with Mare Orientale on November 17th, 2003.

Fig.1 shows the libration diagram for May 2004. The dots represent each day in the month, with every 5th date being marked. The lines between the dates show the orientation of the moon in the intervening periods. The way to read this diagram is to pick the date you're interested in and measure left/right to the vertical axis to see how many degrees the moon has rotated North/South (a positive value (e.g. +4° for May 7th) shows that the Lunar North Pole is better placed for observing. A negative value indicates the South Pole is better placed. The higher the number of degrees, the more the tilt towards the observer and the better your chance of seeing extreme northern or southern features.

Likewise, for East/West librations, drop a line from the date you're interested in to the horizontal axis. A negative value indicates the Western limb is better placed for observing and a positive value indicates the Eastern limb. The higher the number of degrees, the better your chance of seeing extreme eastern or western features.

Fig.1 shows geocentric lunar libration - that is, libration as it would be seen from the centre of the Earth. Such diagrams are "generic" and can be used by anyone on the planet and will give a reasonable approximation of libration as seen from where you live. However, if you want the most accurate representation of libration, you

The Moon Below the Equator

Those of you who have traveled in far-southern climes will be aware that the moon as seen from Southern latitudes does not look the same as when seen from Northern latitudes - it looks upside-down!

As we know, all bodies, including the moon, rise in the East and set in the West. In the Northern hemisphere, the bodies travel from left to right across the southern sky. In the Southern hemisphere, it's the opposite - the moon (and everything else) travel from right to left across the northern sky.

However, the above is merely a generalisation. From just south of the equator (say, Mombasa, 4° S), the moon can often appear in the **south**, and appear to travel from left to right across the sky, just as it does to northern hemisphere observers. That's because the ecliptic extends to 23.5° S and with the moon's inclined orbit, it can appear a further 5+° south than that.

In such circumstances, it would appear to move from left to right, getting highest up in the south - much as the summer sun appears to do from, say, the Canaries.

Of course, the converse can apply to locations just north of the equator, where the moon can someties appear in the **north**! That's something to look out for if the moon is near its northern limits the next time you're in the South Carribean, Gambia, Sri Lanka, Southern India, Bankok, etc. So you could be facing north, looking at Polaris above the north horizon and see the moon pass to the North of you, moving from right to left.

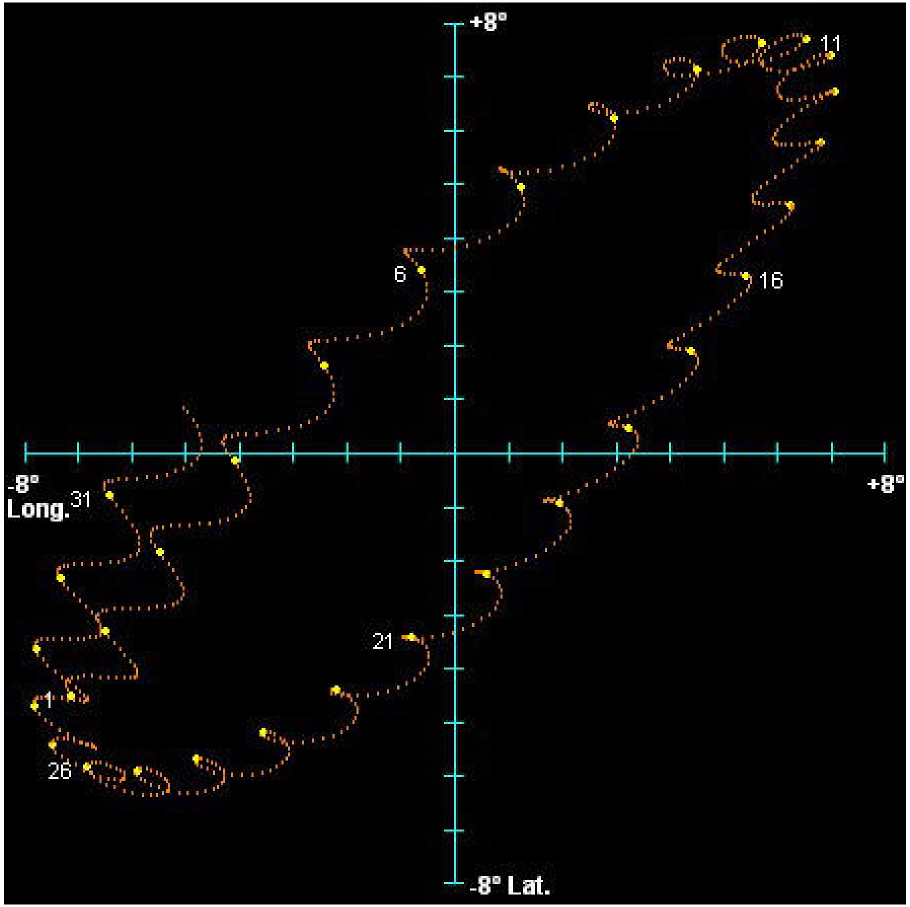


Fig.2: Topocentric Libration Diagram for May 2004 (Dublin, Ireland)

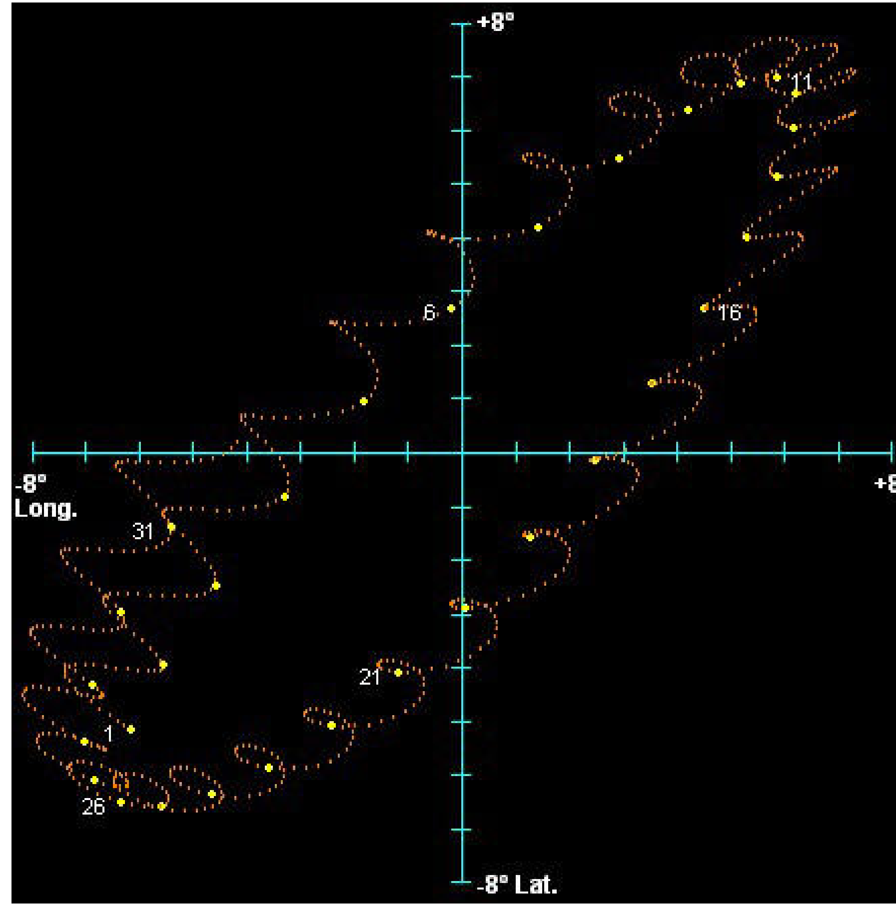


Fig.3: Topocentric Libration Diagram for May 2004 (Los Angeles, USA)

need to look at a Topocentric Libration diagram. These take account of the fact that we live on the surface of the planet and not at its core! They include the diurnal effects detailed earlier.

The Topocentric diagram for May 2004 (figs.2 and 3) show the oscillations that the moon goes through on a daily basis - in this case, fig.2 is for Dublin, Ireland. Fig. 3 shows the diagram for Los Angeles. If you examine the two diagrams, you'll see subtle differences between them, showing that libration is different from different parts of the planet.

If all this sounds too technical, just remember that libration and these diagrams give you, the observer, a

The Rabbit in the Moon

The Lady in the Moon

Fig.4: Other moon features

clue as to when to point your binoculars or telescope at the moon to see limb features that are normally very difficult to see due to the foreshortening of seeing them edge-on.

Moon Illusions

As children, we all heard about how certain lunar features conspired to create the illusion of the Man in the Moon. There are, however, quite a few other illusory figures that can be seen when looking at a full moon with the naked eye. What image you (potentially) see depends on the season, your location and the time of night. Fig. 4 shows two of the figures.

The Moon Illusion

Have you ever had the impression that the moon looks larger on the horizon when rising than it does when high in the sky? This, in fact, is an optical illusion. If you hold your thumb and index finger a pencil width apart and hold it at arm's length, you will always be able to fit the moon between them no matter where it is. It's simply a matter of perspective - the moon looks bigger next to a tree than when it is overhead and surrounded by black.

That, at least, is the simplistic explanation. If you wonder why this famous moon illusion occurs, you should read the article at the web address below, for, as illusion researchers know, a new explanation is needed, because the explanations currently offered by textbooks and the popular media (including most of the sites on the internet) simply do not explain the moon illusion.

The article reviews and applies a new theory of "size" illusions previously presented (since 1983) only in a few technical articles in specialized psychology publications. It is catching on among illusion researchers. This article is long because, first of all, it describes the moon illusion more completely than do conventional discussions, and in a very different and more logical way. Secondly, it reviews the currently best-known theories, and shows why vision scientists (psychologists) don't accept them. Thirdly, it reviews the new theory which proposes that the moon illusion is merely an example of the less familiar, but ubiquitous, "size" illusion known as oculomotor micropsia/ macropsia. Finally, in order to complete the theory, it reviews an explanation for oculomotor micropsia.

In other words, the new theory for the moon illusion is not simple: But it currently is the most satisfactory explanation.

You'll find it at: **The Moon Illusion Explained**

Photographing the Moon

This topic alone deserves a dedicated article (any takers?) but I'll give some basic information on taking photographs of the moon.

One of the big mistakes that beginners make when trying to photograph it is in using a camera that has a lens with too short a focal length. Although the moon may seem quite large to the naked eye with a goodly amount of detail being visible, when photographed the resulting image is (unexpectedly) small and appears as a small dot on the print or slide, with little detail recorded.

In order to demonstrate how large (or small) the moon appears on a 35mm film frame, take a look at fig.5 which shows a number of photographs of the Moon through different lenses ranging from a wide angle lens of 24mm focal length right up to a 1600mm focal length telephoto (an 800mm lens with a 2x telecon-

Fig.5: The size of the moon on a 35mm film frame as produced by lenses of different focal lengths

verter) - these last two would also be in the focal length range of popular 4-5" refractors and 8-10" reflectors.

As you can see, you really need a focal length of 800mm or over for results that show significant lunar detail. 1600mm - 1800mm focal lengths allow the moon to fit in the frame easily.

A simple calculation will let you determine the image size of the Moon on 35mm film:

Focal Length of Lens (mm) / 110
= Size of image

So, for a 800mm focal length lens, the size of the image would be (800/110) or 7.27mm, roughly one-third of the height of a film frame.

Using Teleconverters

It is often said that teleconverters degrade an image and should be avoided, and that they also lose a lot of light, typically 2 stops for a 2x converter.

However, an image produced with a teleconverter is *far superior* to an image taken with the same lens without the converter where the image is enlarged to the same scale.

Why is this? Well it's down to the resolving power of the film. If you enlarge a negative or transparency you enlarge the grain, and the amount that the teleconverter degrades the image is less than you lose by enlarging the film. You also have the added advantage of having a larger image on your film frame in the first place.

You need not stop at one teleconverter; two 2x converters can be used together and the results are quite acceptable, far better than enlarging the image afterwards.

As to the light loss, well, we're talking about photographing the 2nd brightest object in the sky, so you can afford to sacrifice a little in order to get better images.

There's no doubt that a 1000mm lens will produce better images than a 500mm with a 2x converter but large lenses are very expensive whereas 2x converters are not. You'll likely find them in the "used" section of camera shops for a few tens of euro or dollars. Just make sure that you get one that's designed for your camera.

What Camera to Use?

The best type to use is a Single-Lens-Reflex (SLR) camera as this allows you to manually adjust the parameters for making an exposure (shutter speed, aperture, focus, etc.) SLRs also allow you to interchange lenses of different focal lengths.

Automatic cameras are not suitable as under exposure can occur if the light sensor of the camera is in the centre of the image, where the bright moon will cause the camera to either stop down the lens or reduce the exposure time.

The opposite may occur if the sensors pick up more of the background. Also, automatic cameras tend not to work so well in sub-zero temperatures (Winter astrophotography). It's better to use an SLR camera or, if you must an automatic, use one that has a manual over-ride.

Always try to mount your camera on a tripod or rest it on some stable platform to cut down on image shake.

What Film to Use?

As the Moon is a bright object, slow fine grain films can be used rather than the courser grained fast films. The best results are achieved with the slowest films such as Kodak Technical Pan 2415 (ISO 25) for black and white photographs and Kodak Kodachrome 25 for colour slides. Any film with an ISO rating of 50 or less will give good detail on any photos you take.

The faster the ISO rating of the film, the larger the film grain and the more degraded your picture will become. Using fine-grained films is more important if you're using low-power telephoto lenses as you need to record as much detail as possible in the small area of the film frame occupied by the moon.

Calculating Exposures

The moon is lit by sunlight, so it should be treated as any daytime object would be on Earth, even at night! Always bracket your exposures - take one at a slower speed setting and one at a higher setting. This makes it more likely that you'll capture a good image. As a reference, Table 1 lists exposures for typical camera lens f-ratios and lunar phases. It should only be used as a starting guide though!

Digital Cameras

While these cameras are not well suited to taking direct images of the moon, they come into their own when used at the eyepiece end of the telescope. Placing the camera over the eyepiece (in place of your eye) and taking a photo using this eyepiece-projection method can yield some pretty impressive pictures. It should be possible to achieve good results using the cameras with binoculars as well, but you will need to

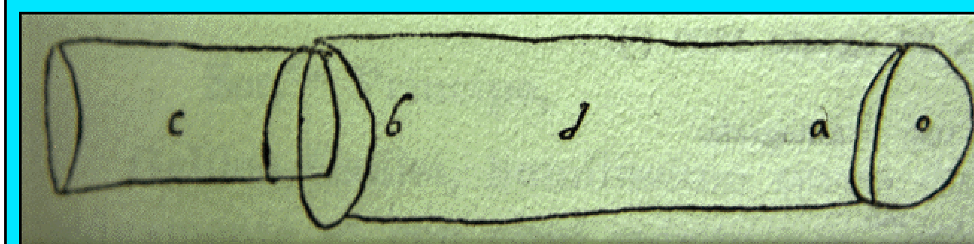
Was Galileo the first to Turn a Telescope Towards the Moon?

The telescope, when invented, was a very humble and simple device. It is possible that in the 1570s Leonard and Thomas Digges in England actually made an instrument consisting of a convex lens and a mirror, but if this proves to be the case, it was an experimental setup that was never translated into a mass-produced device.

The telescope was unveiled in the Netherlands. In October 1608, the States General (the national government) in The Hague discussed the patent applications first of Hans Lipperhey of Middelburg, and then of Jacob Metius of Alkmaar, on a device for "seeing faraway things as though nearby." It consisted of a convex and concave lens in a tube, and the combination magnified three or four times. The gentlemen found the device too easy to copy to award the patent, but it voted a small award to Metius and employed Lipperhey to make several binocular versions, for which he was paid handsomely. It appears that another citizen of Middelburg, Sacharias Janssen had a telescope at about the same time but was at the Frankfurt Fair where he tried to sell it.

The news of this new invention spread rapidly through Europe, and the device itself quickly followed. By April 1609 3X spyglasses could be bought in spectacle-maker's shops on the Pont Neuf in Paris, and four months later there were several in Italy. Thomas Harriot observed the Moon with a 6X instrument early in August 1609. Harriot's observation of sunspots of December 1610 is also the first on record. But although Harriot shared his observations with a group of correspondents in England, he did not publish them.

It was Galileo who made the instrument famous. He constructed his first 3X spyglass in June or July 1609, presented an 8X instrument to the Venetian Senate in August, and turned a 20X instrument to the heavens in October or November. With this instrument he observed the Moon, discovered four satellites of Jupiter, and resolved nebular patches into stars. He published *Sidereus Nuncius* in March 1610.



The earliest known illustration of a telescope. Giovanpattista della Porta included this sketch in a letter written in August 1609

have your binoculars sturdily mounted.

Some Final Tips

- Don't be afraid of taking many photographs in one session. Shoot a whole roll of film if you can afford to do so, just in order to get one or two good photos.
- Avoid camera shake by using a good tripod or solid platform .
- If its windy, find a sheltered spot - it will cut down on vibration.
- Check the sky conditions - poor seeing (turbulence in the atmosphere) will affect your results
- Try taking some photos of the moon in a daylight sky

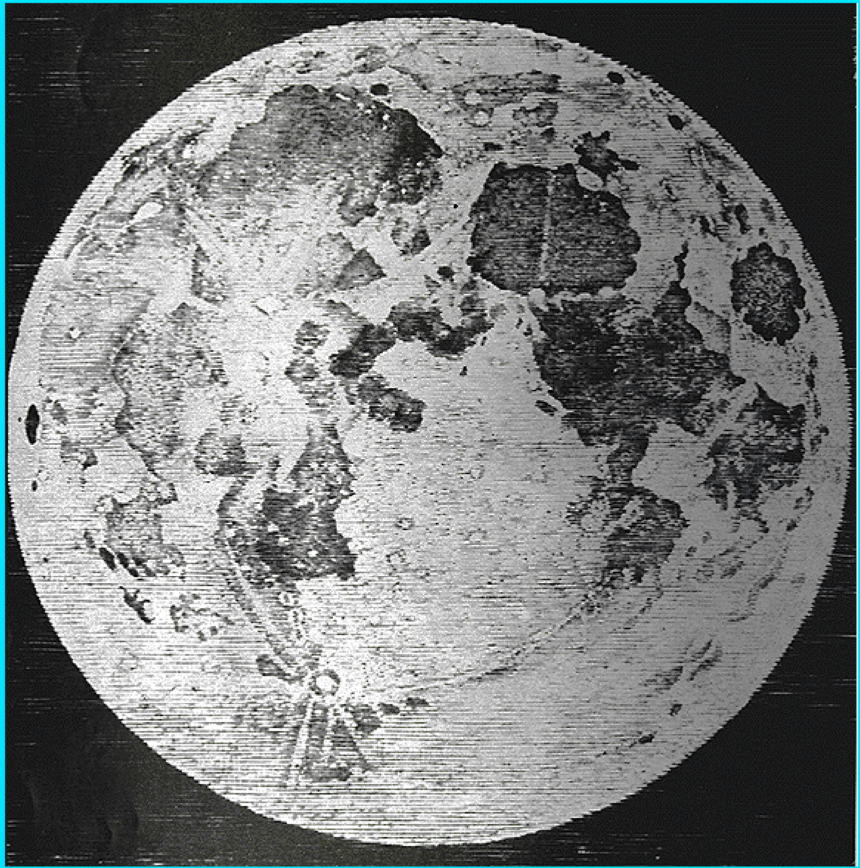
Lunar Libration diagrams produced with **LunarPhase Pro**

Table 1: Lunar Phases (Exposure Times in Seconds)

f	Thin Cres.	Wide Cres.	Quarter	Gibbous	Full
1.4	1/125	1/250	1/500	1/1000	-
2	1/60	1/125	1/250	1/500	1/2000
2.8	1/30	1/60	1/125	1/250	1/1000
4	1/15	1/30	1/60	1/125	1/500
5.6	1/8	1/15	1/30	1/60	1/250
8	1/4	1/8	1/15	1/30	1/125
11	1/2	1/4	1/8	1/15	1/60
16	1	1/2	1/4	1/8	1/30
22	2	1	1/2	1/4	1/15
32	5	2	1	1/2	1/8
45	15	5	2	1	1/4
64	45	15	5	2	1/2
90	-	45	15	5	1
128	-	-	45	15	2
250	-	-	-	45	5

Early Moon Map

The French artist, Claude Mellan, was the first person to produce a detailed map of the moon in the late 1630s. Commissioned by Pierre Gassendi (canon of Digny in Provence, France) and his colleague Nicolas Claude Fabri de Peiresc, Mellan used a telescope of Galilean design which afforded a very narrow field of view, taking in less than a quarter of the moon's diameter.



It Started With A Dandelion

By Remy Bosio

Those of us who, back in the late seventies, were nibbling at perfecting the task of becoming amateur astronomers, simply plodded through the old textbooks, got advice from senior amateur astronomers and it seemed to us that all was right with the astronomical world.

Then a bright young man appeared on the "Telly" with a dandelion between his fingers and "presto" most of us were thrust into a cosmological impression which would lay the foundation for our future adventures in amateur astronomy!

Carl Edward Sagan had finally found a way to broaden not only the horizions of we enamored amateurs, but the average man on the street as well!

What a wondrous feat it was! Night after night, all I could do was anticipate what the "hairy wise owl", as I used to call him, would drum into my already "open" but astronomically disorganized bucket of a brain. What sense he made! What profound thoughts he generously applied to my countenance! I felt better about the world around me with each and every episode! Where was this guy all my life! What a teacher! What a role model.

Quickly, some members in our local astronomy society (including myself) became "Saganistic"! We even went out and bought "tan corduroy jackets and turtle neck shirts" trying, in our own childish way, to establish a life presence with "The Man". I can still recall sitting alone trying to say "Billions and Billions" like Carl did in hopes of sounding more intellectual! Yes, astronomy was on a roll!

After his series left the airwaves, local astronomers still bloomed anew. More reading was done, larger telescopes were built and purchased. Again, all was right with the astronomical world! His cosmological roller coaster was careening along, gathering new riders with every twist and turn. All because of that beautiful dandelion held by a tan-coated man child called Sagan. Who would have thought that anyone would have had the grit to try to persuade that stoic world to study and appreciate astronomy during such politically errant times! Carl thought it was worth it and thrust every ounce of his being into making it so!

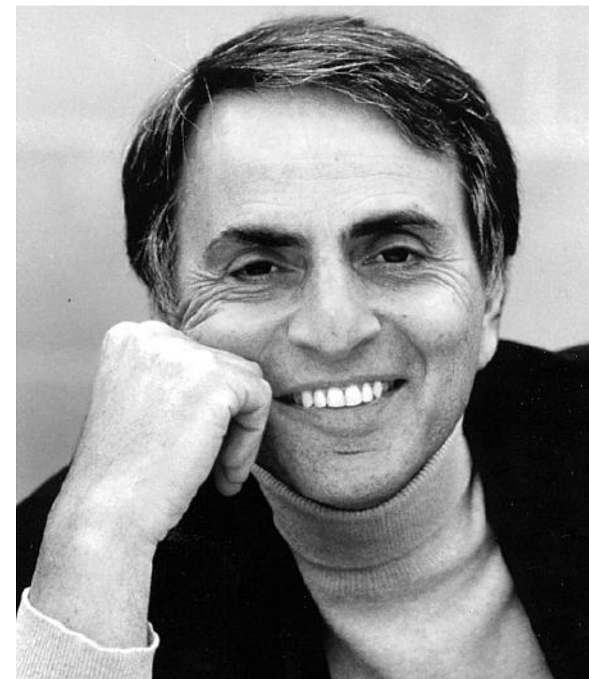
Yes, Carl Sagan did this and even more notable things for stargazers. He spearheaded many JPL projects which are continuing to bear fruit to this day. Let us not forget his devotion to the search for extraterrestrial intelligence, his Brocas, his Dragons, his Pale Blue Dot, his Contact. Carl Sagan's mortality was a boon to astronomers in every venue. His mind transcended the bounds of Earth but somehow he managed to be every ounce a huminitarian.

The gift of Carl Sagan will always be remembered with freshness and devotion by this amateur.

He made me love the Earth. He made me love the Cosmos. He made me love to Wonder!

Godspeed brave dandelion, all is right with the astronomical world.

Remy Bosio is Secretary of the:
Pontchartrain Astronomy Society, Inc.



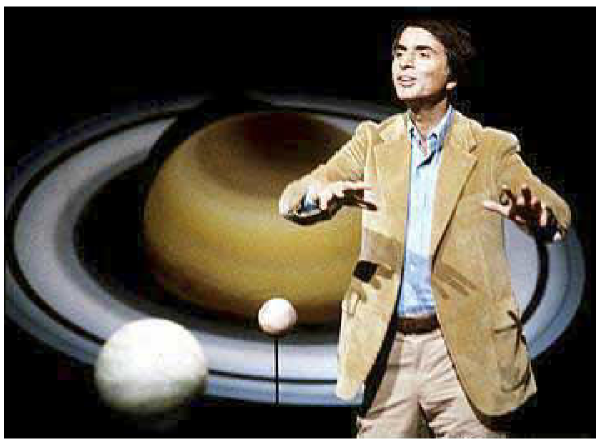
COSMOS - The Collector's Edition

By Gary Nugent

Introduction

Do you remember Carl Sagan's *Cosmos* series from the early '80s? I've often wondered why this series has never been repeated, even on satellite tv which is king of old-series-regurgitation. Covering all aspects of the natural world, from evolution to extraterrestrial life, Cosmos has not been equalled. And the miniseries' creator and narrator, Carl Sagan, was, arguably, one of the foremost scientific geniuses of the 20th century, a fact often belied by his desire to present the mysteries and joys of scientific exploration to the masses.

Born in New York City in 1934, Sagan was a pioneering scientist who participated in virtually every NASA interplanetary expedition during his lifetime. A professor at Cornell University, he determined that Venus was a greenhouse-hell of heat while Mars was essentially a cold, barren desert. He was instrumental in placing a "message plaque" on the Pioneer 10 mission in 1971, which illustrated the location and appearance of its human creators (an idea that evolved into the plaques and phonographs that were included on Voyagers 1 and 2). He also predicted that Titan, one of Saturn's moons, contained the building blocks of life before the two Voyager spacecraft confirmed it in the 1980s.



And yet, despite all of his scientific innovations and discoveries, Sagan will always be remembered foremost as a great communicator - a man who was not content with merely delving into the mysteries of the universe, but who felt the need to reach out to the public and convey his unbounded enthusiasm for science and also to talk about his hopes and fears for our civilisation.

Reaching Out

Starting with a series of books written for the average reader (the first being The Cosmic Connection in 1973), Sagan proved himself a master of parable and metaphor, illustrating complex scientific theories and arguments in everyday vernacular. More books followed, including the Pulitzer Prize-winning The Dragons of Eden. In 1977, he extolled his opinions in the Royal Institution Christmas lectures. In the early 80's he wrote his only novel, Contact (a movie version of which was released in 1998), which chronicled one of Sagan's pet projects, the Search for Extraterrestrial Life (SETI).

Like most tenured academics, Sagan's efforts often focused upon gaining government funding for expensive scientific programs, but his desire to live outside of the Ivory Tower, to make a connection with the person on the street, was undeniable, and probably unmatched by any scientist in history (Patrick Moore aside). Sagan's death from pneumonia on December 20, 1996, a complication arising from a two-year battle with bone marrow disease, robbed the science world of one of its most creative researchers and articulate spokesmen.

Public appearances, books, and television were the tools of his cause. the crowning achievement of which was *Cosmos*. First appearing in 1981, this was a television event only surpassed by Ken Burns' The Civil War some years later. It has been estimated that *Cosmos* was seen by 50 million people, and it succeeded through Sagan's storytelling instincts.

Black Hole

So why did *Cosmos* apparently disappear into a black hole after its initial screenings? Originally produced by PBS with corporate sponsorship, the home-video rights were obtained by Ted Turner, winding up at MGM during his brief tenure there. But the rights were later passed over to Warner, who gained control over the entire Turner library during a complicated cash-and-movies deal with MGM in early 1999. *Cosmos* used to be available on VHS tape, but only in the American NTSC video format (who remembers the ads in Sky & Tel and Astronomy?). The only problem was that *Cosmos* wasn't even on VHS anymore - it had been out of production for about a decade. Drop by the eBay online

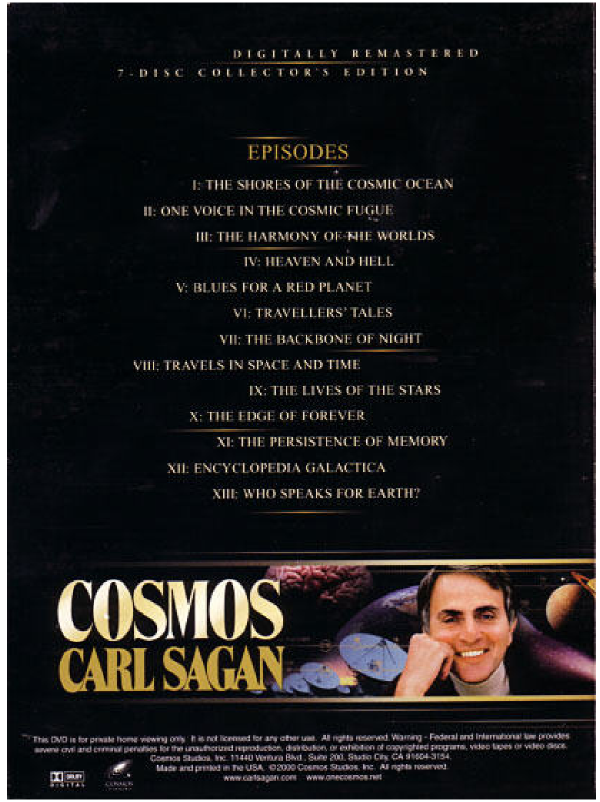
auction site if you're in a shopping mood, where an original boxed-set of seven videotapes in good condition (with Sagan's companion book) traded for a whopping $400 and up. The laser disc version was even more rare when it was produced. A set of these went to auction and were sold for around $1,000.

Rights to the *Cosmos* series were fully acquired by [Carl Sagan Productions] (which was set up by his widow, Ann Druyan) and the series was finally released on both VHS tape and DVD in 2000. Yes, the series has been available for a few years now, but if you're not old enough to remember it, or have never had the opportunity to see it, it is well worth going out of your way to acquire a copy. The Collector's Edition has been digitally remastered; the 13 1-hour episodes have been restored and enhanced and some new footage has even been added.

Cosmos Reborn

The VHS Boxed Set contains 7 NTSC VHS tapes (if you don't live in the U.S., you'll need a video player that can play NTSC tapes), each with Hi-Fi Stereo audio quality.

The DVD Boxed Set contains 7 discs. This is a Region 0 release - a fully international release - so it will play on any DVD player anywhere in the world (but will require a television that can display NTSC material - any TV less than 5 years old should suit). In terms of video, these episodes vary somewhat in quality. The new footage is obviously first-rate, but you have to remember that the series was originally produced using a documentary style combination of film, analogue video and other sources. Despite that, however, the video has been digitally remastered and enhanced. It looks quite good overall. It's a little edgy at times, the analogue video looks a little soft and you'll see some mod-



erate grain from film sources. But colour and contrast are generally fine. While the video quality ranges from excellent to adequate, the average is very good. It goes without saying that the picture quality on the DVDs far surpass those of the VHS tapes and they won't wear out after repeat viewings. The audio has also been remastered and remixed, and is available in English Dolby Digital 5.1. The series' score (including both contemporary and classical pieces of music) is also available on a separate DD 5.1 track - a nice touch. The discs provide subtitles in French, Italian, German, Spanish, Mandarin, Japanese and English for the hearing impaired. Again, a nice touch.

The [VHS boxed set] cost $119.95 while the [DVD Boxed Set] costs $129.95, both available from Amazon.com, but the DVD boxed set is available for $97.50 from [DVDPlanet].

What to Expect?

Cosmos is science in bite-sized servings, with each of its 13 episodes addressing a separate element of natural history or scientific discovery.

Intrigued yet? It's amazing how well the series has aged. The science contained in these episodes is, by and large, still valid today. Only occasionally has something related onscreen been made obsolete by new discoveries. And, thankfully, this series has been updated very cleverly in these situations. A special "science update" subtitle track is available as an option on the DVDs. If you turn it on, text will occasionally appear onscreen indicating that a new discovery or theory has arisen, and explain the implications for the information being presented in the original episode. For example, when this series was first produced, it hadn't yet been conclusively determined what ended the reign of the dinosaurs. In one of the episodes, Sagan refers to the possibility of a comet colliding with the Earth. If you have the update track on, you'll see text which explains that recent discoveries have yielded fairly conclusive evidence that a large asteroid was the culprit.

In addition to the "science update" subtitle track, a few of the episodes also have video updates as well. These appear at the end of the episodes in question, and were shot prior to Sagan's death. They feature Sagan (or Druyan), who explain in more detail the latest dis-

coveries and information relevant to the episode. Finally, from time to time, original video footage contained in the episode has been replaced with more compelling visuals - shots of stars and nebulae have been updated using images taken by the Hubble Space Telescope, for example. The spirit of the original moment in the episode is always retained.

Retrospective

It's been 20-odd years since I last saw this series and, despite it's age, it still has a lot to offer the casual viewer as well as those already interested in the subject matter. It's refreshing to see a presenter who's so in love with his subject, that his infectious enthusiasm sucks you right in - the kind of presenter that's rarely seen these days in the bland world of sound bites and “look-at-me-I’m-so-cool” presenters. Offhand, I can only think of two other such personalities: David Attenborough and Patrick Moore. It's a shame that none of the terrestrial channels have shown Cosmos again - there's a whole generation out there who have missed out on one of the best science series ever to have appeared on television. And, since the likelihood of the series being transmitted in the near future is just about zero, I'd heartily recommend that you get your hands on one of the boxed collector's sets.

This is TV as it should be - interesting, no ads, music that doesn't sound like it was composed on a second-hand synthesiser, and filming techniques that won't make you seasick (no wobbly camera work, no close-ups of someone's right nostril, no filming the presenter in wide-angle from his feet; in short, none of the "arty" techniques often employed these days in documentary making in an attempt to 'jazz up' what the producers obviously feel is boring material). Phew!...I'll stop ranting now...Cosmos - buy it, you won't be disappointed!

Cosmos Episodes

I. The Shores of the Cosmic Ocean - Sagan explains quasars, exploding galaxies, star clusters, supernovae and pulsars through the magic of special effects. Back on Earth, there's a recreation of the ancient Library of Alexandria, seat of learning on Earth 2,000 years ago.

II. One Voice in the Cosmic Fugue - Sagan uses a "cosmic calendar" to make the 15 billion year history of the Universe understandable and discusses the evolution of life from the first microbes to modern humans.

III. The Harmony of the Worlds - A historical recreation of the life of Johannes Kepter, the first modern astronomer, provides insights into humanity's understanding of the Moon and planets.

IV. Heaven and Hell - A descent into Venus' hellish atmosphere to learn about the dangers of pollution and runaway greenhouse effects. And a journey through the solar system to understand the effects of cosmic catastrophes.

V. Blues for a Red Planet - Sagan examines the possibility of life on Mars and looks at humanity's historical perspective of the Red Planet in both science and science fiction.

VI. Traveller's Tales - The 17th Century sailing expeditions of the great Dutch explorers are compared with the Voyager spacecraft's modern journey to Jupiter and Saturn.

VII. The Backbone of Night - How the ancient Greeks struggled to understand the nature of stars in the Milky Way. Sagan also looks back at his own childhood in Brooklyn, to a time he was asking himself the same questions.

VIII. Travels in Time and Space - How constellations change over millions of years, there's a journey to the planets of other stars and the possibility of time travel is considered through the eyes of a young Albert Einstein.

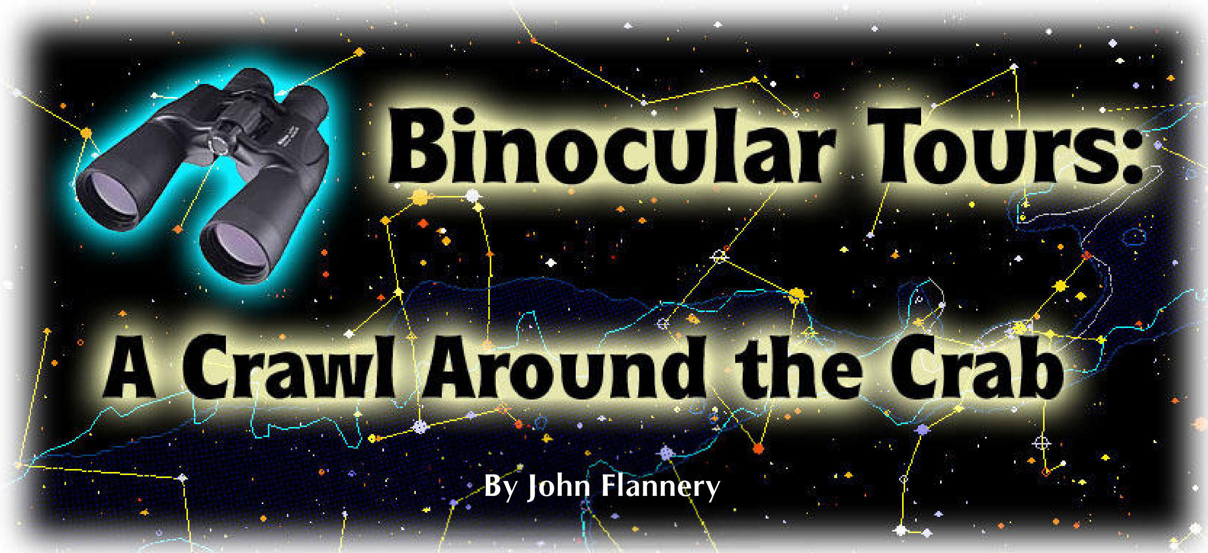
IX. The Lives of the Stars - Using computer graphics and stunning photographs, Sagan examines the way stars are born, live and eventually die as supernovae or black holes. Then it's 5 billion years into the future, to witness the last perfect day on Earth.

X. The Edge of Forever - A series of fantastic trips depicts the birth of the Universe, the development of galaxies and the very edges of space.

XI. The Persistence of Memory -The human brain is examined in relation to intelligence and the nature of thought. Another of Earth's intelligent creatures are examined - the whales.

XII. Encyclopedia Galactica - Sagan asks the question, "Are we alone?" He journeys to the farthest reaches of space to visit the worlds of hypothetical alien civilisations and examines our modern Search for ExtraTerrestrial Intelligence.

XIII. Who Speaks for Earth? - In the final episode, Sagan retraces the Universe's 15 billion year struggle to awareness through the development of intelligent life. He discusses the danger we pose to ourselves through nuclear war and other follies, and argues that our responsibility for survival is owed not just to ourselves, but to the very Cosmos from which we spring.



Binocular Tours: A Crawl Around the Crab

By John Flannery

I recently did a spot of observing with my trusty 20x60mm binoculars. It was also an opportunity to reacquaint myself with some of the familiar celestial sights after a winter of little observational activity.

Just past the meridian, as soon as darkness falls during April evenings, is the zodiacal constellation of Cancer, the Crab. Though dim, and literally a footnote in the legend of Hercules (the mythological strongman crushed the hapless crab underfoot during his battle with the multi-headed Hydra), Cancer nevertheless holds a number of delightful objects for the binocular user.

The Crab's pattern is not readily apparent at first but it is usefully flanked by the prominent constellations of Gemini and Leo - the former presently hosting the planet Saturn, the latter containing Jupiter. Only from a dark site though, will you begin to trace the Crab's outline as just two stars are above fourth magnitude.

The brightest is b **Cancri** (+3.59), or Al Tarf ("the End"), an orange giant that is estimated to be fifty times the diameter of our Sun. It is also a double, although the fourteenth magnitude companion is well beyond the range of binoculars. The physical separation between the two is quite large - on the order of 2,600 astronomical units - while their orbital period is reckoned to be about 76,000 years!

a **Cancri**, (+4.25), or Acubens ("the Claw"), is ranked only the fourth brightest star in the Crab and is a pure white sun of spectral class A. Interestingly enough, it is a tight spectroscopic double with both stars of equal luminosity separated by just 5 astronomical units. The presence of a nearby faint twelfth magnitude red-dwarf companion that is itself a double makes for a rather interesting quadruple system.

Acubens is also the jumping off point for our venture into deeper space to find the ancient galactic cluster, **M67**. Keeping the star towards the left (eastern) edge of the field of view (3°) in the 20x60s, the duster is seen as an elongated mottled haze about two degrees to the west. On my second evening out observing the area, I was able to see a sprinkling of the brighter 9th magnitude members of this association while an unrelated 8th magnitude sun lay just outside the northern edge of the group.

M67 is considered to be one of the oldest galactic dusters known, with an estimated age of four billion years. This poses the question as to how its members have remained gravitationally-bound over such a long period of time. Most open star dusters are disrupted after a few hundred million years following encounters with other clusters or by successive passages through giant interstellar gas clouds during their circuits around the galaxy. The key to the survival of M67, however, lies in its own orbit that brings it to a great distance (1,500 light years) high above the plane of the Milky Way.

The vast majority of open star clusters are spawned amongst the great clouds of gas and dust that are concentrated within a few hundred light years of the galactic plane. M67, on the other hand, is well removed from its original nursery as its orbit takes it high above the disk leading to less frequent adverse encounters with its kin. The age of the cluster's stars is similar to that of our Sun and, indeed, its members happen to have a similar chemical composition as the Sun.

One of the most celebrated objects in the sky is

The open cluster, M67

Praesepe, or **M44**, the Beehive star duster. It is visible to the naked-eye as a spot of light framed by d, g, h, and q Cancri, makng up the "body" of the Crab. The proper names for g and d Cancri - Asellus Borealis and Asellus Australis - come to us from Greek myth where they represented the donkeys on which the gods Dionysos and Silenus rode into battle against the Titans, who were so frightened by the animals' braying that the gods won. As a reward, the asses were put in sky together with the manger - presumably to ensure a perpetual supply of hay!

But before having a peek at the group, stop briefly at **X Cancri**, a dun-hued semi-regular variable that lies 2.75° east-southeast of d Cancri. The period is 195 days and the brightness fluctuates between magnitude +5.6 and +7.5. A handful of sixth and seventh magnitude stars are sprinkled across the field.

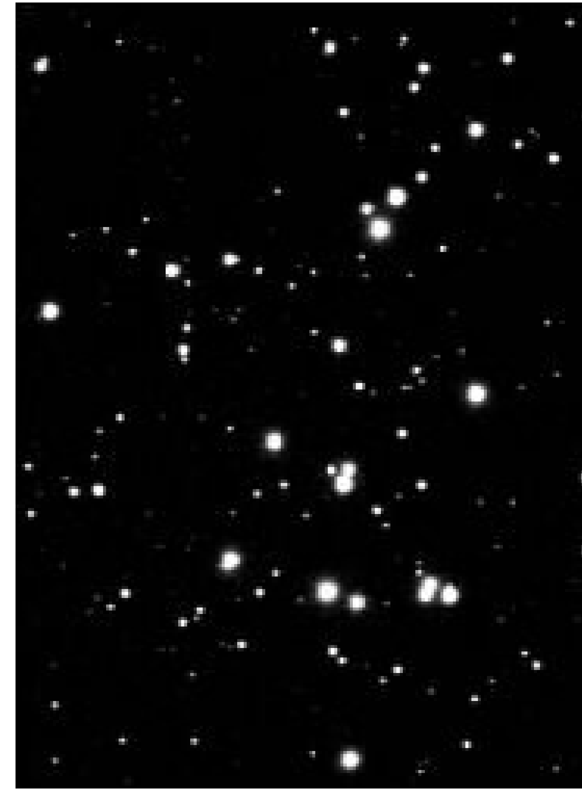
Praesepe, or Phatne (the Manger), has been known since ancient times and the first recorded mention of it is in the great weather and sky lore poem *Phaenomena* by the Greek author Aratus who wrote in 260 BC:

"*And when with deep-charged clouds the air's opprest,*
Phatne, the spot that shines on Cancers breast,
Attentive mark: if bright the spot appear, Soon Phoebus smiles with face serene and dear,
Nor the returning rain and tempest fear."

Indeed, the visibility of the cluster with the naked eye has long been regarded in folklore as an indication of weather conditions. Although the sky transparency was not that good on the two nights I ventured out, Praesepe was clearly visible without optical aid but I have seen it more distinctly on occasions. It was not until Galileo turned his telescope skyward though, that the true nature of the Beehive became apparent; "*The nebula called Praesepe, which is not one star only, but a mass of more than 40 small stars.*"

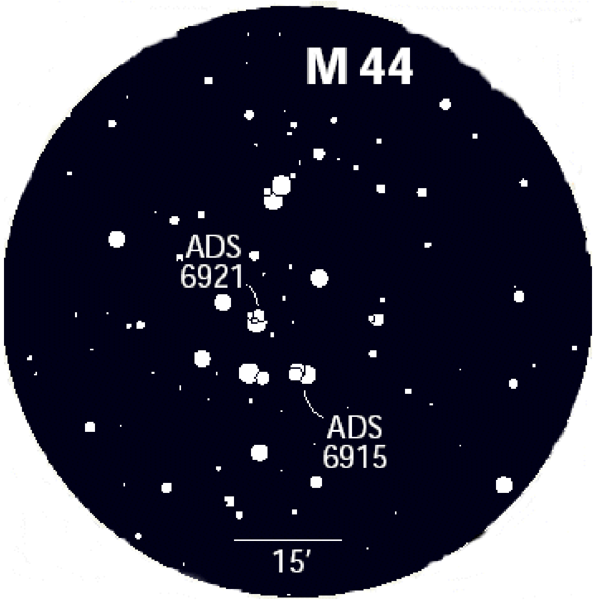
Binoculars are the ideal instrument to examine this sprawling cluster and to resolve the stars swarming around an imaginary celestial honey pot. The brightest member of the group is e Cancri, a +6.3 magnitude star that is 70 times as luminous as the Sun. If we could place our Sun in the midst of M44, it would appear as a feeble magnitude +10.5 spark of light as seen from Earth.

I made no effort to count the number of visible members, as I was more intent on finding two doubles that reside within its boundaries - **ADS 6915** (Burnham 584) and **ADS 6921** (see chart of M44). Both lie towards the southern edge of the cluster as part of a sort of tipped-over "house"-shaped asterism that also reminded me of a miniature Cepheus.



M44, aslo known as Praesepe or The Beehive

ADS 6915 is a triplet of suns of around seventh magnitude at the "roof" of the "house" with the star right at the apex of the triangular arrangement being brightest. ADS 6921 is a quadruple system but only the two more luminous members will be seen in binoculars. A fifth-



A chart of M44, Praesepe

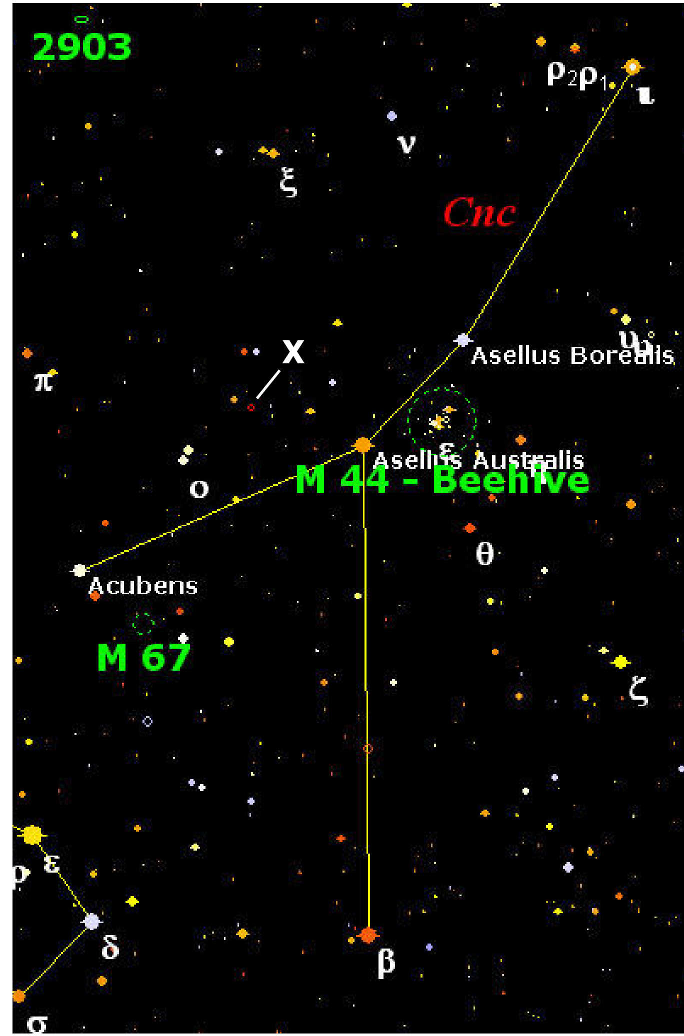
magnitude satellite that sped through the field as I was observing was a nice bonus.

Recent measurements by Hipparcos place M44 at a distance of 577 light years with the cluster's age estimated to be about 400 million years. This fixes it at the same age and distance as the equally well-known Hyades in Taurus and has led astronomers to believe that both groups were born in the same area of space long ago. A third member of the so-called Hyades superduster is NGC 1901 in the southern constellation of Dorado. The whole subject of galactic superdusters (as distinct from ***galaxy*** superclusters) offers a fascinating insight into stellar evolution and associations.

Taking our leave from M44, we now head northwards to the beautiful double star, ι Cancri. The separation is 31" and the magnitude +4.2 primary appears yellowish with the magnitude +6.6 companion glowing bluish-white. The star is set in a lovely field that shows two nice curving chains of stars tapering to a point. Again, I teased out a miniature constellation shape; this time the pattern partly reminded me of a diminutive Perseus. Another nice star field is centred on the line of a stars, tagged 1 through 4, from west to east. We finish our tour, though, with the rather unassuming **55 Cancri** - a sixth-magnitude sun that is also labeled r^1 on charts. The star is a member of the exclusive club of those stars recently found to posses a planetary system. Only one attendant planet is known at present though a second more massive body is suspected in the data.

The confirmed extra-solar planet orbits its parent in only 14.6 days at a distance of 16.5 million kilometres - or 28% the distance of Mercury's orbit from the Sun. The mass is slightly less than that of Jupiter. 55 Cancri is a G-type dwarf slightly cooler than the Sun and is 41 light years away.

Before I packed up on the second night to head home I took a moment to reflect on how the tour of Cancer ranged from doubles to clusters, stellar evolution to the cutting edge of research on extra-solar planets, and finally, to the human connection with the skies above. We may have gazed at the night sky countless times, but when we become aware of the stories behind the sights, then we ourselves - and our hobby - are that bit richer.



The constellation of Cancer, the Crab, showing the positions of open clusters M67 and M44

Building Your Own Observatory II

(or maybe that should be how NOT to build your own observatory...)

By Gary Nugent

Picture 1: The floor frame covered in plastic for damp proofing. Four 3"x3"fence posts are bolted to each side of the floor leaving 3"x3"gaps at the corners

Having installed the pier and leveled the top plate (as described in the previous article), I made sure that everything was rock solid and that I could easily polar align the telescope before beginning construction of the observatory itself.

First Ideas

At the time I was considering building the observatory I checked out a variety of plans and approaches that were available on the internet ranging from simple roll-off roof designs to increasingly more sophisticated hinged roof section designs and on to backyard observatories implementing geodesic domes. The Doghouse roll-off roof in the June 2000 issue of Sky & Telescope was of particular interest.

My skills being very meager meant that a dome design was just too sophisticated and well beyond my abilities. So I decided on constructing a roll-off roof design. The various plans I'd investigated gave me some ideas but because some parts used in those (principally American) designs were unavailable, I ended up designing the observatory from scratch rather than adhering to someone else's plans.

How Big?

The first thing to take into consideration was the overall size of the observatory. My back garden is large, so I wasn't limited by the space available. What was important was measuring the full length of the telescope with attached CCD camera and other accessories and making an allowance for my own girth at the back of these optical combinations. The overall width of the observatory was worked out to be six feet (outer wall to outer wall). [A real mixture of imperial and metric measurements would be utilised in the final construction!]

Picture 2: First attempt at laying the floor, flush with the edges of the floor frame

Since I also needed room for keeping various accessories and a work table, the length was chosen to be 8 feet rather than making the observatory square.

Another consideration was how high to make the observatory. Since I live beside a lane-way, I didn't want the observatory to be easily seen by passing opportunists. This limited the overall height, including roof, to 6.5 feet. The observatory walls also had to be high enough to protect the telescope from being buffeted by the wind and from low lying stray light but not tall enough to restrict horizon views. Due to surrounding trees, houses and walls, the minimum elevation I can reliably see from the site is about 30 degrees above the horizon. With all this in mind, a wall height of 5 feet was chosen.

What Orientation?

The garden is roughly oriented with the cardinal compass directions, so the issue of which direction the roof would roll off was based on which area of the sky was worst affected by light pollution, surrounding trees and intrusive street lights. I also didn't want to have the rails and roof intruding further into the main garden area and spoiling it.

I eventually decided to align the building's long axis in the east-west direction and have the roof roll to the east. That part of the sky is partly blocked by nearby trees anyway and suffers light pollution from neighbouring buildings.

Construction Begins

Looking around the local DIY suppliers, I ended up buying treated 2"x3" beams for the construction of the various frames in the observatory. The wood was cut to size using a hand saw and nailed together using 150mm nails.

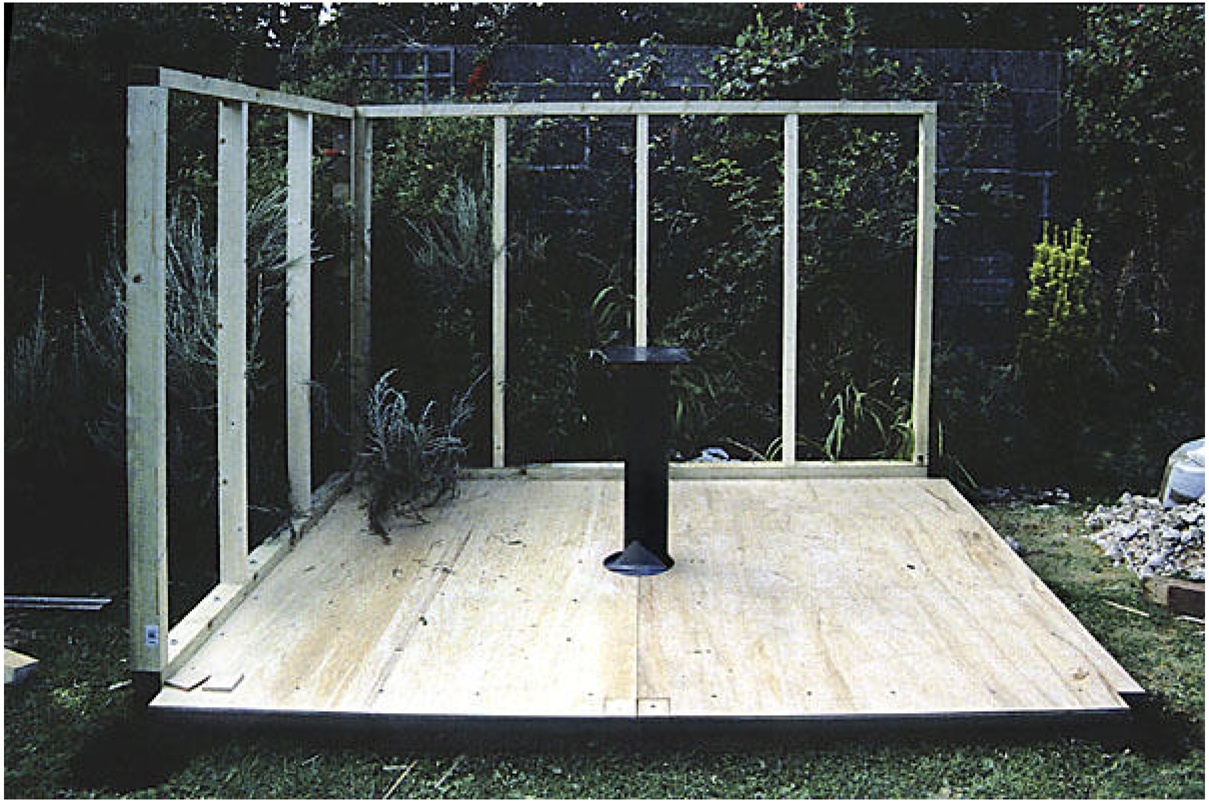
I started out with the floor frame. The struts were placed 20" apart (10" apart either side of the pier) with a small 10" square frame being centred in the floor to surround the pier. The pier had to be passed through this hole so the floor frame could be positioned correctly. The frame was then roughly lined up parallel with the wall. The corner points were marked, the frame rotated out of position and 1 foot deep holes dug at each marked point. These would later take fence posts which would be cemented into position.

The floor was then rotated back into position and four 3"x3" treated fence posts were bolted to each of the four sides of the floor frame (see Picture 1). The floor was then leveled by placing wooden shims under it where necessary. Thick plastic (a mixture of damp-proofing plastic and hardwood underlay plastic left over from a re-flooring job in the house) was then stapled on top of the frame to prevent damp rising from the ground and into the observatory. It would also prevent the floor from prematurely rotting.

The floor itself was cut from two 8'4 pieces of plywood with a 10" diameter semicircle being cut in each piece which would fit around the pier. The two pieces were then screwed down onto the floor frame. 3" square cut outs were taken from the corners where the vertical fence posts would eventually fit (see Picture 2).

Walls

Three wall frames were then constructed - one each for the short sides of the observatory and one for the long side at the back of the observatory. These were screwed into position, through the floor and into the fence posts previously bolted to the floor frame, using 150mm coach screws (see Picture 3). These screws (which have hexagonal heads for use with ratchet spanners) can be hard to find. Home base had a selection whose entire stock I eventually purchased! But even that wasn't enough. Luckily, the local old-style hardware store had a stock of them as well ...at half the price Home base were charging!



Since I also used up Homebase's supply of 2"x3"s, I contacted a timber merchant about supplying the rest of the timber and plywood for the project. No surprises for guessing that the prices were again about half that charged by Home base! If only I'd thought of it sooner!

Design Mistake

With three wall frames in position (see Picture 3), heavy clouds rolled in and a tumultuous downpour began. Sometime later, when the Sun reappeared, I inspected the water damage. As expected the wall frames were fine (being treated wood) but the floor (even though it was marine grade plywood) was saturated. Since the wall frames were flush over the edges of the plywood floor, all water that had run off the frames was now seeping into the floor through its exposed edges.

All the coach screws were removed and the three wall frames taken down. I lifted the floor and re-cut it so that it would fit within the inner boundaries if the wall frames rather than being flush with their outer edges. Lifting the floor was more difficult than anticipated as the heads of some of the screws had been damaged when the floor was initially laid and some proved to be particularly stubborn in removal. The floor was eventually coaxed from its moorings and reshaped.

The three wall frames were then screwed directly onto the horizontal fence posts. At this stage, two 3"x3" fence posts were screwed into the two corners formed by the three wall frames. This time 100mm coach screws were employed. The posts were mounted flush with the tops of the wall frames but extended about 9" into the previously dug corner holes where they would later be cemented into position. The addition of the two fence posts anchored floor and walls together into a solid structure.

The next addition was the fourth wall. This was to go at the front of the observatory. Since the door was to go on this side as well, the wall width was shortened with this in mind. A third 3"x3" fence post was screwed into position at the new corner, solidifying the structure even further.

Roof Design

Being a roll-off roof design, I had looked around for materials that would facilitate some kind of wheels on/in track arrangement. The roof also had to roll off somewhere, so the idea was to have the tracks extending from the observatory walls for another 8 feet - the length again of the observatory. Needless to say, the tracks would need to be supported at their 'free ends.

Unfortunately, I couldn't find the right kind of materi-

Picture 4: The basic frame for the observatory including rails stretching out to the right to their supports and the door.

als, especially ones that would stand up to repeated use when subjected to a heavy load. What I did find were some 2.5" neoprene castors (the fixed rather than rotating kind) which were mounted in sturdy aluminium frames. The frames contained four holes for bolting the wheels to furniture. The wheels are slightly over 1" wide. They're also quite tall given the additional height imposed by their housings.

Rails

Since I couldn't find any material that could be pressed into service as a running track, I ended up cutting a 1.25" wide (this width was found by trial and error using one of the castors with a spare block of wood), 0.5" deep rectangular groove in two 3-metre long pieces of 2"x3" using a router. Several passes were required for such a deep groove but an attachment lets the tool cut parallel with an edge, so getting a groove central along the full length of the beams was not a problem. What was a problem was that the 2"x3"s weren't long enough to cover the full run of the roof, so two beams had to be joined end-to-end on each side of the building. More work with the router.

With the rails cut to length, the short pieces were bolted (using 150mm carriage bolts) into position first. One went from the top of the leftmost corner fence post to about half way along the top of the rear wall frame. The other was bolted to the top of the nearside corner fence post (where the door would be placed), crossed the gap left for the door and the remainder was bolted to the nearside wall frame (see Picture 4).

With the two short rail lengths in position, the remaining 2"x3"s were clamped in position, parallel with the nearside and farside wall frames. Using a plumb, the positions immediately below the ends that extended into the garden, were marked. The beams were then taken down (to avoid injury).

Rail Supports

Two 3" square, 24" long, metal fence post holders were hammered into the ground at the marked positions. These post holders can be a problem. Should they hit a large stone or rock on their way down, they have a tendency to rotate off square. One of the posts encountered such a problem as it was hammered in and it was only through brute force that it was deformed slightly and rotated back into position. Levers are wonderful things! In my case, the stone encountered was about 18" down in thick clay and it was impossible to actually lift the post holder out of the soil, so the leverage was brought to bear.

One other problem with such post holders is that they can veer off vertical as they're hammered in. Constant checking with a spirit level is essential. Having gone through these tribulations, I'd recommend that the posts be cemented in position instead!

With the post holders in place, the fence posts were inserted and individually measured and cut to length to take into account any minor differences in the depth of the post holders. The posts were then positioned verti-

Picture 5: The basic skeleton including the roof which was temporarily placed in position to evaluate how well the wheels traveled within the rails

cally using a spirit level and the post holder locking screws tightened to fix them in position. A cross-beam was cut and fashioned to fit between the two vertical supports, both to keep them a fixed distance apart and to provide a more solid framework.

Mounting the Rails

With everything now in place, the two long rails were mounted in position butted up against the existing short rail sections, bolted parallel to the long wall frames and screwed onto the top of the two vertical supports. Two "fill-in" 2"x3" pieces were then bolted to the two shorter wall frames, between the two rails. This ensured a level surface around the top of the walls.

The Door

Since the aperture for the door was a non-standard size, I ended up building the door from scratch. The basic door was made out of one 3"x3" fence post (to house the lock) and three 2"x3"s nailed together into a rectangle. A small margin was left around all four sides to allow the door to open and close and allow for expansion in damp conditions. Two 2"x3" cross beams were added about 15" from the top and bottom of the frame to improve rigidity and provide anchor points for the hinges. I decided against the classic Z type support as I wanted to be able to be able to make fine adjustments to the frame (to make it slightly off square) should that become necessary (which it did).

Galvanised steel garden-shed type hinges were chosen for connecting the door to the nearside wall frame. These hinges have a standard rectangular end for fixing to a door frame; the other part of the hinge is long and triangular for fixing to the front side of a door. I routed recesses in the two door crossbeams to the depth of the hinges which were then screwed in place. The door was then set in place and the positions of the rectangular hinge ends marked on the wall frame. These sections were then chiseled out. The hinge ends were repositioned and screwed into place.

In practice, there was still some friction between the door and the door frame, so the offending sides were planed and sanded until smooth opening and closing was achieved.

The position for the mortise lock was then selected. Opposing holes were cut in the door and door frame for the lock components and a hole cut for the key. Bear in mind that the door was still just a frame at this point. The lock was tested and adjusted until I was happy with its operation. Building and hanging the door turned out to be the most time consuming part of the entire project.

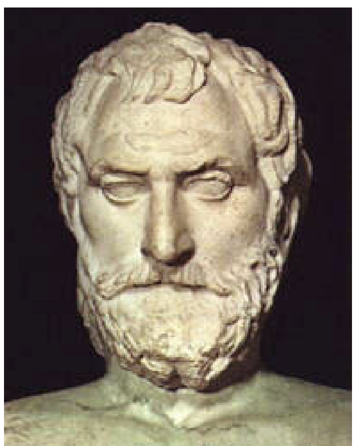
Roof Construction Because of the height limitation of 6.5 feet and the wall height of 5 feet, the maximum roof height would be just 18". The minimum height was just 2". This was to be the next phase in construction.

(To be continued)

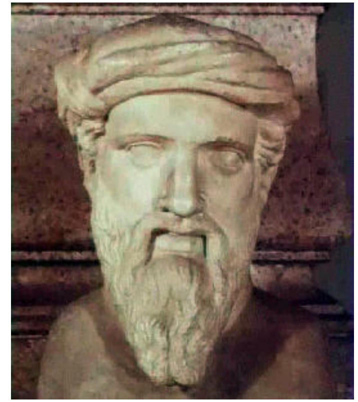
The Great Astronomers

By Tim Carr

Isaac Newton once remarked that if he had achieved more than other men, it was because he had "stood on the shoulders of giants". In truth, Newton was probably as great an intellect as ever lived. Long before his time, long before Kepler, Tycho Brahe, Copernicus and Galileo, long before the scientific revolution that dragged Europe out of the dark ages, there lived men whose ideas and discoveries marked the very beginnings of science as we know it. When their civilisation died out, their achievements seemed to die with them, and Europe would have to wait for 1500 years before the torch of rational thought could again be ignited.


Thales (624-546 BC)

The Greeks who migrated from their homeland to the coastline of Asia Minor in about 1800 BC were different to their contemporaries in Babylon and Egypt. These people were tough, practical and, most importantly, democratic. Not democratic by our standards, certainly, but at least they were not theocratic. Without dogma to retard their development, they began to use mathematics and astronomy, not to make astrological predictions or divide up land for irrigation, but to navigate, map the heavens and understand the Universe itself.


Pythagoras

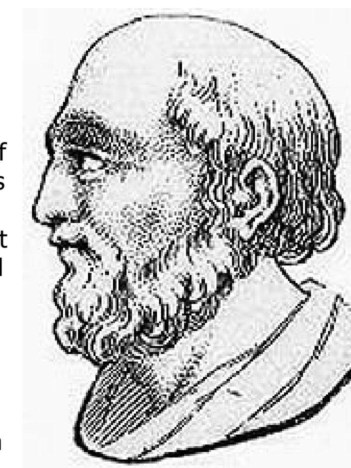
Thales (624-546 BC) is generally thought of as the first Greek scientist. He correctly predicted a solar eclipse in 585 B.C. But, more importantly, he was the first person to ask himself what the cosmos was made of and to try to come up with a scientific, rather than a religious, answer.

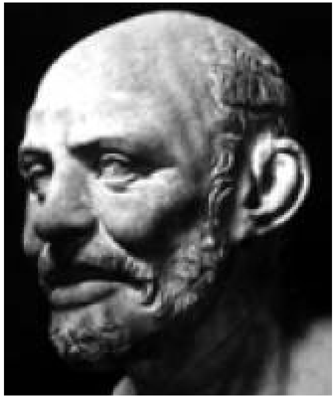
The conclusion he reached was that the basic element was water, which of course is wrong, but at least he was trying to answer the question rationally.
One of Thales' friends was Anaximander. He accurately measured the length of the year and the seasons, using nothing more than a stick in the ground. He knew that the stars appear to revolve around the Pole star, therefore introducing the idea that the sky is a sphere, not just an arch over the Earth. For the first time the idea of spheres entered cosmology.

Perhaps the most influential of all the early Greek scientists was Pythagoras. Well known to students for his (in)famous theorem, his influence on Western civilisation was immense. He was the first to teach that the Earth was round and the first to see that the orbit of the Moon was not in the plane of the Earth's equator. His greatest work was on sound and the belief that numbers ruled the Universe. This, of course, is nonsense. However, his fascination for numbers encouraged later generations to study mathematical relationships further. Astronomy without mathematics would be only half a science.

Anaxagoras (580-428 BC) was a rationalist, unlike Pythagoras (a mystic), who explained the phases of the Moon and eclipses accurately. He believed the Moon was rather like the Earth, and that it might even be inhabited. He was also the first man to state that the Moon shines by reflected light. This notion was so unappealing at the time that it had to be circulated secretly.

One mystic who actually came very close to explaining the basic structure of our solar system was born in southern Italy in 480 BC. At that time, the Greeks had colonised much of the southern region of Italy, and Philolaus had to return to Thebes to escape persecution. His idea was that all the planets, including the


Anaxagoras



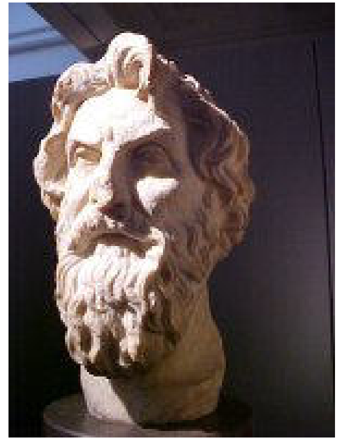
Democritus

Earth, orbited a central fire, represented by the Sun. In fact his motivations for advancing this theory was more mystical than scientific, but it was still a remarkably accurate theory for a man who lived four centuries before Christ.

"I would rather understand one cause than be King of Persia". Democritus, the man who uttered these words was born around 470 BC in Abdera, the original one-horse town. In him, it produced a man whose deductions were literally thousands of years ahead of their time. The man from Abdera believed that all matter consisted of tiny, indivisible particles, which he called atoms. He also believed that the Universe was made up of worlds that formed as swirling clouds of matter collided together. Other suns had planets orbiting about them, and the Milky Way was nothing more or less than a broad swathe of innumerable stars.

Little is known about what happened to him, or even when he died, but his brand of rationalism leaves us today, gaping in amazement that someone could have been so right, so often, so long ago.

Aristarchus of Samos (320-250 BC) was a man whose ideas were so modern as to rival those of Democritus. One of the last of the great Ionian scientists, he held that all the planets revolve around the Sun. From the size of the Earth's shadow on the Moon during a lunar eclipse, he deduced the Sun to be much larger than

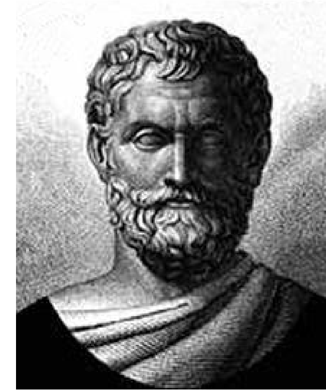


Aristarchus

the Earth, and much farther away. He also calculated the relative distances of the Moon and Sun from Earth. Although the answers he calculated were wrong, it was due more to a lack of accurate measuring tools, rather than a lack of brain-power.

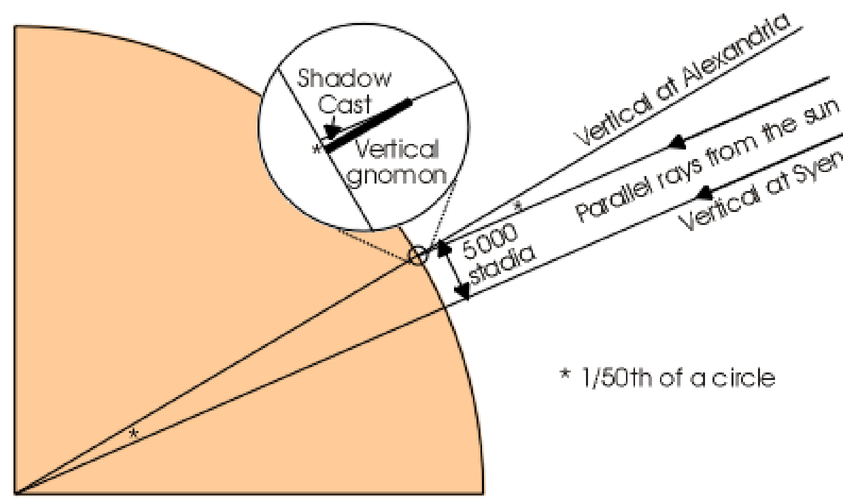
The idea that the Earth is just another planet orbiting the Sun was far too much for his contemporaries, and did not gain much credence. Not for nothing is he known as the Copernicus of Antiquity.

Eratosthenes of Cyrene (276-196 BC) was what would later be called a Renaissance Man. As interested in history as astronomy, geography as philosophy, mathematics as poetry, he was colloquially known as 'Beta', because he was said to be the second best in the world at everything. A friend of the great Archi-medes, he achieved far more than could be dealt with here, but among his greater achievements were a star map with 675 stars, a value for the angle of the Earth's axis to the plane of



Eratosthenes

the Sun's apparent motion in the sky, a map of the British Isles, and many, many more. You name it, and he did itl There is one thing for which Eratosthenes is remembered above all else. In the great library of Alexandria, of which he was a director, he read one day, that at midday on the longest day of the year, June 21st, the Sun shone straight down a deep well at Syene, near the first cataract of the Nile, and also that a column or stick placed there would cast no shadow.

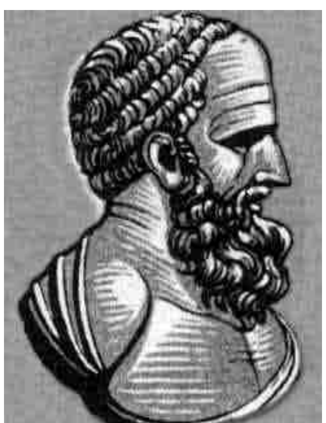


Eratosthenes experiment

In other words, the Sun was directly overhead. However, a stick in Alexandria, to the north, produced a definite shadow on the same day.

If the Earth was flat, he reasoned, and the Sun was very far away, then the Sun's rays would be virtually parallel, and should produce the same shadows everywhere. So why didn't they?

Most people would not have cared two hoots about the problem. But Eratosthenes was not like most people. He calculated the difference in the lengths of the shadows made by two sticks of equal length, one in Syene, the other in Alexandria, measured at the same time. From this he deduced the angle between the two sticks. Obviously if the sticks were at an angle, then the ground must be curved between the two sites. He realised that the Earth must be spherical and calculated its circumference to be 25,000 miles. This is a remarkably accurate figure for a man who lived 2200 years ago.



Hipparchus

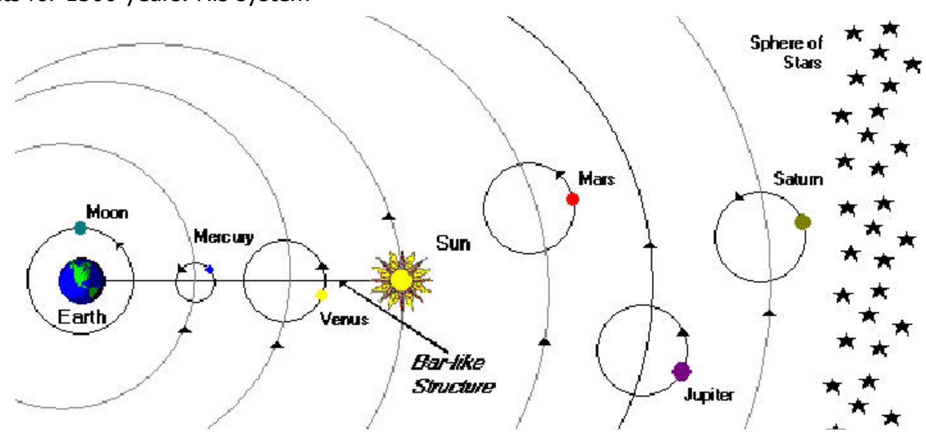
Perhaps the greatest observer of the Ancient Greeks was Hipparchus (190-120 BC). Using parallax to accurately measure the distance to the Moon, he virtually founded trigonometry. In 134 BC he observed a star in Scorpio which appeared in no records that he had. This was quite disturbing to the Greeks who believed the heavens to be unchanging. In order not to be surprised again, he set out to provide a very accurate star map. To plot the star positions on the sky he used a grid reference of latitude and longitude, as was already used on maps. We use Hipparchus' method to this day. He also noticed a slow shift in the stars' positions from West to East. This is called the Precession of the Equinoxes, and is caused by a wobble in the Earth's axis. Not only did Hipparchus notice it, he calculated the length of time that it takes for the Earth's pole to complete one circle, 26,7000 years.

He was the first to classify stars according to their brightness, and tried to work out a new system to explain the Universe. The Earth was the centre of the Universe, and everything revolved in spheres. The planets revolved in small circles which themselves orbit the earth in larger circles.

The last of the great Greek astronomers was Ptolemy (85 AD - 165 AD). Perhaps not even a Greek, he nevertheless gave the world an explanation of the Universe which fit all the known facts for 1500 years. His system is basically that of Hipparchus, but as the latter's writings have not survived, it is Ptolemy who gets the dubious credit. The system stated that the Earth was at the centre of the Universe. The planets, Sun and stars revolved around it, fixed on crystal spheres. He also used the epicycles (smaller circles) proposed by Hipparchus. To us, the system is silly and cumbersome, but to the people of that time it fit the available data very well, and for them, that was enough.

Ptolemy

By this time, Greek science was in decline. The teachings of Plato and Aristotle, which urged people to turn away from the 'real' world and concentrate, rather, on thought and introspection, took hold. Greece faded, and with no other civilisation to carry the torch of reason and knowledge, Europe descended into the Dark Ages. When the intellects of Europe decided to open their minds to the 'real' world again, some 1500 years later, it was upon the work of the Greeks that they built their knowledge.



Ptolemy's conception of the solar system

Showcase

If you have images/photos, please consider sending them in to us.

Cover Picture: Rays in Summer Triangle Nov 20/21, 2003. Taken from Co. Wicklow, Ireland, with a 28mm wide angle lens. Kodak Elitechrome 200 ISO with 35 sec. exposure at f/2.8. Photo: © John Flannery

Right: M51 (The Whirlpool Galaxy in Ursa Major). Prime focus images through a Vixen VC200L 8" reflector at f/6.3 (using a focal reducer) using a Starlight Xpress MC516 CCD camera and STAR2000 tracking. Ten 5-minute exposures stacked. Photo: © Gary Nugent.

Bottom Left: Auroral Red Rays covering the Summer Triangle on 29th/30th October, 2003. Taken from near Kells, Co. Meath, in Ireland with a digital camera. Photo: © Gerry Moloney.

Bottom Right: The 22° radius Halo with Sun Dog shot in the Canadian Rockies, Alberta. There was also a Sun Dog on the east side of the halo. A telescope blocks the sun. Digital Camcorder still, 30th April 2003. Photo: © John O'Neill.

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We're looking for submissions for the next and future issues, whatever part of the world you live in.

Issues 1 and 2 should give you a flavor for the kind of articles we're looking for. Tell us about any astronomical trips you've been on, whether they're to local or national Star Parties or vacations based around an astronomical event such as a solar eclipse. Give us warts-and -all reviews of equipment you own, from a lowly pair of binoculars, to eyepieces to large expensive telescopes. Let us know what you think of recent books on astronomy or your appraisals of astronomy software, whether they're freeware, shareware or commercial applications; profile your club or society; tell us about any equipment you've built or modified; tell us about your experiences with astrophotography and send us some of your results. We will be paying for any material used in future issues.

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